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THE ECLIPSING VARIABLE EPSILON AURIGAE.

By DEAN B. McLAUGHLIN.

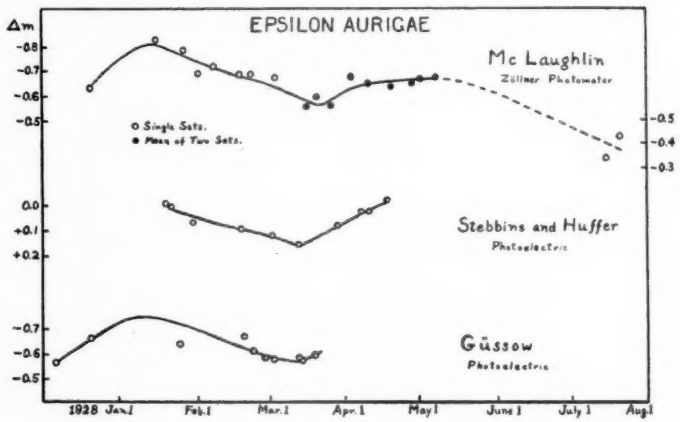
The bright star Epsilon Aurigae, the one of "The Kids" nearest Capella, is unique among known eclipsing variables as regards length of period and behavior of the spectrum during eclipse. The period of revolution is 27 years, and the eclipse lasts two years, during one year of which it is total. The spectrum of the star is classified as F5p and is characterized by the great prominence of enhanced lines of titanium. It closely resembles that of Gamma Cygni. According to spectral criteria it is a super-giant star, and it has been included by Adams and Joy[1] in their list of pseudo-Cepheids. The photometric orbit has been calculated by Shapley.[2] Assuming that the mass of the system is double that of the sun, he finds that the diameter of the bright component is between 73 and 169 times that of the sun. If the mass is in keeping with the high luminosity, the dimensions must be at least twice as great. The faint companion would then be more than a match for Antares or Mira in size.

The spectroscopic phenomena are of a puzzling nature. According to Ludendorff,[3] a plate taken just after totality had begun in November, 1901, showed diffusely bordered and unsymmetrical lines. Several appeared as wide lines, on the redward side of which was superimposed a stronger narrow absorption line. The spectrum observed during total eclipse was identical with that shown by the star when at maximum brightness, save only for the quality of the lines. When the star was coming out of eclipse the same asymmetry was noticed but it was now in the opposite direction.

The depth of eclipse, 0.74 magnitude, would indicate that the two components of this binary are of equal luminosity. In spite of this, no trace of the spectrum of the secondary star has been seen when the primary is not eclipsed. Also, the eclipsing companion must have a much lower surface brightness than the smaller bright star, yet its spectral class, as seen during totality, is identical with that of its primary. These observations do not appear to be in harmony with our present ideas of stellar conditions, or with one another. On the other hand, the variable radial velocity of the system has been investigated by Ludendorff[4] and found to agree well with the eclipse theory. The bright star travels in an orbit 12.6 times as large as the orbit of the earth around the sun, and if the masses of the bright and faint bodies are

equal, each is eleven times as massive as the sun. He also showed that there is a velocity variation which shows no constancy as regards either period or amplitude, but which may be roughly described as having a period of 150 days and a range of 12 kilometers. He has shown, from considerations of the probable size and mass of the bright star, that it is practically impossible to account for this as the effect of a third body, and he leans toward an explanation analogous to that of the Cepheid variables.

Ludendorff suggests an interesting and novel hypothesis to account for the eclipse. A huge opaque cloud of meteors travelling about the bright star, and considerably elongated in the direction of its motion, but having a smallest diameter smaller than that of the bright star, would explain the observed light curve. When the forward end of the cloud comes between the star and the earth the light dims until the cloud stretches clear across the disc of the star. The light then remains constant until the rear end of the cloud uncovers the edge of the stellar disc, when the light increases until the cloud has passed.



Probably the total phase of the eclipse has now begun, as measures by the writer show little decrease of brightness since the middle of October. Measures obtained up to July 24 are plotted in the figure, with those of Stebbins and Huffer and Güssow for comparison. The variable is now about $0^m.1$ fainter than Zeta Aurigae, having decreased about $0^m.9$ since January, 1928. The decrease between January 20 and March 14 led Stebbins and Huffer[5] to believe that the eclipse had begun ahead of the predicted date (about May 15). Frl. Güssow,[6] however, showed that this variation is probably characteristic of Epsilon Aurigae outside of eclipse. When last observed by Stebbins and Huffer[7] in April it had regained all that it had previously lost. Therefore, the eclipse probably began close to the predicted date. The author's measures from

March 16 to May 9 were discordant on account of bad seeing at large hour angles, hence they are combined in pairs in the figure.

Although the eclipse is now in progress, the temptation to speculate without waiting for observations is strong. The hypothesis presented below was formulated nearly two years ago when the author was unaware of the publication of Ludendorff's paper on the orbit of the star.

It appeared to the writer that the conflicting pieces of evidence could be reconciled by means of the following hypothesis. Let us imagine a massive, very tenuous star of class F5p accompanied by a considerably larger and more tenuous body, approximately spherical, which is not appreciably self-luminous. It is conceivable that its tenuity may approach that of a nebula, indeed we might consider it as a rather dense dark nebula in a stage intermediate between the true dark nebula and a giant red star. Now the dark nebulae we observe in the Milky Way are undoubtedly transparent to a depth of many astronomical units, or even light-years, else we should be unable to see stars which, like Rho Ophiuchi, are obviously enveloped in them. The dark companion of Epsilon Aurigae may be sufficiently transparent to transmit half the light of the bright star. It appears not impossible that the widening of the spectrum lines during eclipse may be due to anomalous dispersion within the nebulous body. During the partial phases the asymmetry of the lines might be explained by the direct rotation of the bright star, perhaps in a much shorter period than that of orbital revolution. The strongest absorption would thus be due to the uneclipsed portion of the rotating bright star, the weaker, broad absorption to the light transmitted by the nebulous body and affected by anomalous dispersion. It is especially interesting to note that the two largest residuals from Ludendorff's velocity curve are those of groups of plates taken during the decrease and increase of brightness, at which times rotation effect is observed in other eclipsing stars. Moreover, these residuals are in a direction which agrees with the hypothesis of rotation effect, *i.e.* the velocity shows a positive residual before minimum and a negative residual afterwards.

It is natural to ask if such a case as that postulated by this hypothesis has any parallel elsewhere. The writer believes that it has. The variable star R Coronae Borealis is normally of the sixth magnitude, but at uncertain intervals its light suddenly drops several magnitudes, and after a minimum of some months' duration it again increases to its former brightness. Ludendorff[8] considers this variation to be due to eclipse or possibly engulfment of the star by wisps of nebulosity. The behavior of the spectrum of R Coronae is remarkable.[9] At maximum it is of class cG0 with the hydrogen lines lacking, probably due to the presence of emission. At minimum it shows bright lines of ionized titanium where at maximum strong absorption appeared. *The spectral class, however, shows no change but the absorption lines are less sharp at minimum than at maximum.* Herein lies a strong similarity to the behavior of Epsilon Aurigae, and it is difficult to believe that similar

causes are not operating in producing the variation of both these stars. Some stars of the R Coronae class, *e.g.* T Tauri[10] and T Orionis,[11] are known to be associated with nebulosity, which lends probability to the above explanation of their light variations.

The author's hypothesis of a semi-transparent satellite nebula eclipsing Epsilon Aurigae encounters only one difficulty and it may well be a fatal one, *viz.* that the length of path of the light through such a tremendous body is such that, in spite of the extremely low density of 10^{-9} times that of the sun, it should be opaque. The writer calculates that if the nebula were composed of atmospheric air its opacity would be equivalent to that of about 2,000 kilometers of air at sea-level. Possibly the difficulty might be partly removed by postulating a mixture of meteorites and gases, although the hope of success of such an hypothesis appears slight.

Possibly a combination of the ideas of Ludendorff and the author is as hopeful as anything we can think of. A narrow, extended cloud of meteors, dust, or gases would account for the eclipse as previously explained, while a much more tenuous envelope of gases would cause only a slight dimming of the light of the star, but would produce the widening of the lines by anomalous dispersion.

Perhaps it is too much to hope that the observations at the present eclipse of Epsilon Aurigae will give a final answer to the question of the nature of the system, but we should certainly learn much. Observations of this star with photoelectric cells are being carried on by Stebbins and Huffer in this country and at Neubabelsberg in Germany. The author is following it with photometer and spectrograph. A two-prism spectrogram taken on the morning of July 24 shows that no noticeable change in the character of the lines has yet occurred. Since then 20 single-prism spectrograms have been obtained. No certain evidence of change has been found, although a few of these show Hδ slightly unsymmetrical. The measurement of these plates is now being carried on.

It may be regarded as fairly well established that Epsilon Aurigae is intrinsically variable as well as apparently so due to the accident of eclipse. Possibly it will eventually develop that the short period velocity variation is synchronous with the small light changes and that the star is related to the Cepheids. It will be interesting to see what sort of light curve will be obtained in this case of eclipse of a true variable by a body which may not be a star at all.

The stars RZ Ophiuchi and W Crucis with periods of 262 and 199 days respectively, appear to come nearest to providing connecting links between Epsilon Aurigae and more normal eclipsing binaries. Both these stars are of spectral class G. Spectroscopic study of these two cases would be of the greatest interest, but both are so faint that it is probably not feasible at the present time.

[1] Adams and Joy, *P. A. S. P.*, **31**, 184, 1919.
[2] Shapley, Princeton Contrib. No. 3.
[3] Ludendorff, *A. N.*, **171**, 49, 1906.
[4] Ludendorff, *Sitzungsberichte der Preussischen Akademie der Wissenschaften*, **9**, 49, 1924.
[5] Stebbins and Huffer, Harvard Announcement Card No. 61.
[6] Güssow, *A. N.*, **232**, 207, 1928.
[7] Stebbins and Huffer, *Popular Astronomy*, **36**, 306, 1928.
[8] Ludendorff, *A. N.*, **209**, 282, 1919.
[9] Joy and Humason, *P. A. S. P.*, **35**, 325, 1923.
[10] Pease, *Ap. J.*, **45**, 89, 1917.
[11] Ludendorff, *A. N.*, **209**, 275, 1919.

ANN ARBOR, MICHIGAN, NOVEMBER 19, 1928.

THE SOLAR ECLIPSE OF MAY 9, 1929.

By F. J. M. STRATTON.

The eclipse of next year with its maximum duration of totality of over 5 minutes is one of the best eclipses for some years to come. The Sun is in a reasonably good field of stars for the Einstein experiment, totality is long and a number of observing stations, well separated in position, are accessible. The track crosses the northwestern end of Sumatra—the third time this century that Sumatra has seen a total eclipse—the Malay State of Kedah, Siam, the southernmost part of Cambodia and the Philippine Islands.

Detailed information of the weather conditions to be expected in Sumatra have not yet come to hand, though it is hoped that the Bosscha Observatory at Lembang may later report on some sunshine and cloud observations, which have been specially taken for the sake of eclipse observers. The western coast of Sumarta where the eclipse track first strikes land is too swampy to provide a possible eclipse camping site and the choice of observing stations in Sumatra lies between the northeast coast near Idi and the high ground—about 1500 metres above sea level—south of Lake Tawar. Meteorological data available in England suggest that a coast station would be more likely to be free of cloud; but the evidence, pointing to clouds developing about noon at the coast and working inland with the sea breeze, is rather indecisive as to the best station about 13:00 hours local time, and the advice so far received from Sumatra favors the high hill station rather than the coast. A station near Lake Tawar would be dependent for all its facilities, transport, electric power, tents, camping site, etc., entirely upon the Governor of Atjeh, and the Dutch authorities. It would have to be near the extreme end of a military road running south from Takengon.

Despite the warlike reputation of the Atjeh, it would be perfectly safe from molestation but the choice of site would probably be somewhat limited. In any case early negotiations with the authorities of the Dutch Indies is advisable.

In Kedah there are several possible sites. Meteorological observations taken for the last two years round the eclipse date and hour show that though there is not much difference, there is a slight advantage in a station near the coast over one higher up, near the backbone of hills that run down the center of the peninsula. First class metalled roads and a railway cross the belt of totality and there are several quite possible sites for an eclipse camp. Save at Alor Sta, which is to be the headquarters of one of the British expeditions, it would probably be necessary for an eclipse party to get light thatched huts erected under local arrangements—not a difficult nor expensive requirement to meet. Colonel Walery Cohen acting on behalf of the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies, has explored very thoroughly the belt in Kedah and Siam and has placed a considerable amount of detailed information in the hands of the writer. Other eclipse sites in Kedah that may well be considered are at Jitra and Kodiang. The chief doubt affecting the choice of Kedah as against Siam lies in the fact that the monsoon breaks there rather earlier than in Siam. The chances of a clear sky at the eclipse hour changes from about 2 to 1 in April to about even chances in May—taking the month as a whole. The monsoon generally breaks just after the middle of the month so that prospects are favorable save in the event of an early monsoon. In Siam the prospects of a clear sky seem to be slightly better than in Kedah because the monsoon breaks later. But the central line of hills in the totality belt is low and it is doubtful whether there will be much difference as to prospects between the two sides of the peninsula.

The S.W. monsoon generally breaks a little later than in Kedah and the chances of good weather are very fair. The two most suitable sites seem to be at Pattani on the coast and Khoke Bhode on the railway. There will be eclipse expeditions to both places.

In Cochin China the best station for observing is the island of Poulo Condore; accommodation and labor are both available there; the weather prospects at 14:00 hours local time are not favorable, the official estimate being 2 to 1 against a clear sky. In the Philippine Islands, though the Sun is somewhat low in the sky and totality shortened by a minute, weather prospects improve again slightly; the figures given by the Rev. M. Selga, S.J., Director of the Manila Weather Bureau (POPULAR ASTRONOMY, April, 1927, and Report of the Manila Weather Bureau, 1928), do not suggest any better prospects than in Kedah. The two most suitable stations would seem to be at Iloilo and Cebu.

An informal interchange of information between prospective observers took place at the International Astronomical Union at Leiden and some account of this may be given as an indication of what is hoped to accomplish at the coming eclipse. The information is very provisional as many plans are at present incomplete and uncertain. In Sumatra there may be three expeditions, probably all in high ground south of

Lake Tawar. One of them is a Dutch expedition, to carry out the program arranged for the Sumatra eclipse of 1926, spectrophotometry of the chromosphere and corona both in the red and in the ultra-violet and a study of the solar radiation near and through totality. Another is a German expedition from Potsdam which will study the Einstein problem with two different instruments—an astrographic telescope and a coelostat with two camera tubes—and will work on the relative intensities of the lines of the coronal spectrum, and with a spectrograph of high dispersion will attempt to secure improved wave-lengths for the coronal lines.

The third expedition may be from Australia; Mr. Merfield will repeat his observations secured in 1926, but with larger apertures and longer focal lengths. The outer coronal spectrum will be examined for displacement of dark lines: a slit spectroscope with high dispersion would be used.

Two British expeditions from Greenwich and Cambridge are being sent to Alor Sta in Kedah and to Pattani in Siam. The Einstein experiment will be attempted at both stations—by the astrographic telescope at the latter station and a coelostat with a pyrex mirror at the former. At both stations the relative strength at different heights of H and K and the infra-red ionized calcium triplet will be examined and the polarization of the corona will be examined. A falling plate spectrograph and an interferometer for the study of the coronal rotation will be used at Alor Sta and a quartz spectrograph at Pattani.

A German expedition from Kiel will also be in Siam at Khoke Bhode. The photometery, and spectrophotometry of the corona and its spectrum will be examined over a wide range of spectrum with the aid of high light-gathering power. It is possible that the Potsdam expedition may come here instead of to Sumatra. Another German expedition will come from Göttingen, repeating Professor Kienle's program at the 1927 eclipse, spectrophotometry with a falling plate and a radial slit, with high light-gathering power.

Other projected expeditions include an Italian expedition to a site as yet undetermined, a French expedition from the Bureau des Longitudes, to Poulo Condore, with a program of photometry of the corona and a study of the deviation of light in the gravitational field; also a German expedition from Hamburg to Iloilo in the Philippines with a program of direct photography of the inner and outer corona, and a study of the flash spectrum with two objective prism cameras.

Two or three American expeditions are possible. One of them may go to the Philippines with the apparatus taken (without much success so far on account of adverse weather) by Anderson to Sumatra in 1926 and by Rosseland to Norway in 1927. And one American may go to Sumatra. Should information come to hand in time of these or other expeditions, it would be offered for publication or circulated to those particularly concerned.

THE SPECTRAL TYPE OF PROCYON.

By R. H. CURTISS.

At a meeting of the committee on classification of stellar spectra, convened in Rome in 1922, the question was raised whether Secchi's stellar spectral type I should be considered to include the Harvard division F5. It was there agreed that Secchi's classification of Procyon of class F5 should decide the point, since Procyon is the typical star of this division in the northern skies. Subsequently, it was found that Secchi had classified Procyon in type II which was taken to mean that Secchi's type II, and not type I, included class F5, and the records were so amended. Subsequently, Col. F. J. M. Stratton, who raised the question in meeting, designated Procyon as of type I of Secchi. (*Astronomical Physics*, p. 106).

It is brought out below that Secchi finally regarded Procyon's spectrum as of a transition type between I and II, and no doubt found difficulty in classifying it. With the correspondence of the two most widely used classifications of stellar spectra in mind, and possibly in doubt, it is interesting to collect what data we can in this connection and to consider its bearing on the point at issue.

In July, 1866, Secchi (*Comptes Rendus*, **63**, 366) classified Procyon with Arcturus and Capella as feebly colored white stars having a spectrum marked by sharp lines. However, it is probably not profitable to go back of Secchi's list of stars of September, 1866, (*Comptes Rendus*, **63**, 621). for in this list stellar spectra were assigned for the first time to clearly defined types which correspond in characteristics though not in numerical order to later classifications by the same investigator. In this list, Procyon is assigned to type I.

With a considerable extension of the number of stars a classified list was published in 1867 in a memoir by Secchi under the title, "Sugli Spettri Prismatici dei Corpi Celesti." The scheme of classification was essentially unchanged as compared with that of August, 1866. The three types were called respectively, "type of α Lyrae," "type of α Herculis," and "solar type." In this list, of which there were at least two editions, Procyon was assigned to type I or type of α Lyrae. Polaris, of class F8, was referred to as of intermediate type but was assigned to the solar group.

Later in the same year a catalog of stellar spectra appeared as an "Estratto dalle Memorie della Societa Italiana de' XL, 3a Serie, Vol. I." In this, Procyon was assigned to the α Lyrae type with Hβ and Hγ well seen. There were wide and truly dark lines, especially in the violet region, and many narrow lines also. Polaris was again described as of intermediate or mixed type.

In the second volume of Secchi's classical work "Le Soleil," dated 1877, Secchi presented his well-known classification substantially as it stood ten years before, but here he included Procyon in his list of second or solar type stars. However, he stated, (l. c. p. 451), that this star was intermediate between the first and second types.

Finally in his authoritative work, "Die Sterne," edition of 1878, the year of his death, Secchi published lists of stars of the various types in which Procyon was again assigned to the first or α Lyrae type. This was not a mere transcription of his list or catalog of 1867, for it contained additional stars. Furthermore, in the text under his description of type I, he stated, "It is to be remarked, with reference to some stars of this type, such as Procyon (F5), α Aquilae (A5), α Virginis (B2), and others, that we observe many sharp lines of which hardly a trace is found in other stars of this type. These stars constitute a transition to the following type II; there is thus no sharp line of separation between the several types." (The Harvard classes are, of course, inserted by me). The transition stars selected above were not happily chosen except for Procyon itself. Secchi included the other two objects because he saw but did not identify the many fainter lines in addition to the strong lines of hydrogen. But it is at least clear that the intermediate character of Procyon's spectrum was well established in Secchi's mind.

Summarizing Secchi's classifications of Procyon's spectrum, it appears first that he grouped this star with others of the solar type in July, 1866. In September of the same year, when his types were more clearly defined, and again in his memoir and his catalog of 1867, he assigned it to type I with Vega and Sirius. In 1877, however, he classed Procyon with type II but referred to it as intermediate between types I and II. In a work published in 1878, he classed Procyon again in type I and continued to regard it as a transition star between types I and II. Thus immediately after his preliminary classification of 1866, Secchi appeared to regard Procyon as of type I with Polaris of class F8 representing the transition stage between types I and II. But in his later works he moved his line of division upward making Procyon rather than Polaris his transition star between types I and II and thus assignable to either type.

If we attach importance to Secchi's last word it may be difficult to determine which of the contradictory classifications in "Le Soleil" and "Die Sterne" was of later date. However, this seems to matter little. The point is that the spectrum of Procyon was finally regarded by Secchi as of truly intermediate or transitional type. Thus it may well be designated, in accordance with good practice in some other classifications, as of type I - II. The author has followed this procedure in a table of comparative spectral classifications to appear in the "Handbuch der Astrophysik."

ANN ARBOR, MICHIGAN, JULY 26, 1928.

REPORT ON MARS, NO. 42.

By WILLIAM H. PICKERING.

The expected changes on Mars have been so marked and so rapid during the past month, that it has been thought best to describe them at once for the benefit of other observers, although it involves a regrettable delay in the publication of several sets of drawings which were sent to me of the apparition of 1926. It is expected that these changes, which always occur at this Martian season, will continue through November, and perhaps into December. This may involve further delay, but it is clearly important that the remaining drawings of 1926 should appear at the earliest possible moment. It will be recalled that the instrument now employed here is our 12.5-inch reflector, which we always diaphragm down to 10 inches, thereby materially improving its definition. We also always use an electric fan as described in Report No. **41**, POPULAR ASTRONOMY, 1928, **36**, 451. This drives out the warm air at the lower end of the telescope as well as the cold air at the top. The improvement in definition in our case is marked. Many nights when the seeing is only moderate we see as much now as we did formerly with our 11-inch Clark refractor, but with the seeing at its best, the difference between the two instruments is very noticeable, and of course the finest detail detected is always the most interesting. It is believed that the fan could also be used profitably with large refractors of long focus, in case the air at the two ends of the tube is found to be of different temperatures. These instruments might then prove themselves to be distinctly superior for planetary work to those of moderate size. Thus in 1924 a fan, by enforcing a uniform temperature throughout the tube, might have put the Lick telescope far ahead of our 11-inch.

We always use a position circle, which consists of a micrometer which carries a negative eyepiece. The eyepiece gives a magnification of 340, and is fitted with a very fine web. This latter is appreciably finer than those I have seen in the temperate zone, indeed when illumined by sunlight it is only just visible to the naked eye. A negative eyepice for plantary work is distinctly better than a positive one, chiefly because with high powers the little irregularities on the surface of the field lens of the latter interfere with the finer detail of the image. A low power of 240 we find occasionally useful to bring out slight contrasts, such as those between clouds and deserts, which are not easily visible with the higher magnification. It is of no use to attempt to orient one's drawings of Mars by the phase, even when the latter is large,—hence the position circle. If one does not have one, we may orient approximately by the northern polar cap, which will be visible from now on for several years to come. Its southern border is at present, owing to melting during the Martian day, at a position angle of from 95° to 100° with

the planet's central meridian. It is white and due to snow. The large yellow southern cap is due to clouds, and its position angle is unreliable, owing to constant variations.

Our observations began this year on the night of Friday, Saturday, October 5,6. The central meridian in our drawings ω ranged from 8°.8 to 16°.1, the solar longitude $\odot$ was 321°.5, the equivalent Martian Date January 41, the diameter d 10″.4, the latitude of the center +2°.4, and the seeing 4, later 6. The Martian atmosphere was full of cloud, hiding much of the maria. These latter seen through Martian mists were extremely faint, and their outlines indistinct. The northern cap was only just visible. Acidalium could not be seen, though carefully looked for. Ganges and Nilokeras leading to it were faint.

October 8, 9, ω 293°.8, $\odot$ 323°.4, d 10″.6. Martian haze had cleared, and the northern cap, though fully 1500 miles in length, allowing for phase, yet on account of the position of the polar axis was extremely narrow, not over 0″.5. The Syrtis was conspicuous, but ill-defined to the north and on the preceding side towards Libya, which was slightly darkened.

October 10, 11, ω 275°.6, $\odot$ 324°.4, d 10″.7. Heavy precipitation has occurred, darkening Libya and Isidis, so that they are only just distinguishable from the Syrtis. This is presumably from the clouds that we saw preceding the latter. Protonilus is visible though very faint.

October 14, 15, ω 245°.3 to 267°.3, $\odot$ 326°.6, d 11″.0. Isidis has lightened, but as the day progressed, darkened again to equality with Libya. This may have been due to the evaporation of low-lying mists. Both are somewhat lighter than before. Both edges of the Syrtis are dark, like two canals, with Euxinus strikingly so. The lightness of the interior may have been due to cloud, or the edges of the Syrtis may really have been serving as canals. The huge southern cloud cap is characteristic of the month of January in the Martian year, and was recorded in 1925 and in 1926, 27. It advanced 20° towards the north, south of Hammonis, or nearly 800 miles, between October 10 and 14, the Martian hour of the day, which was about noon, being practically the same on the drawings compared. This was unusual and local. It is at the rate of 8 miles per hour, a plausible rate, if there was no condensation or evaporation, for this planetary wind. A straight broad canal joins the northern part of Euxinus to Triton Lake, dividing the Isidis region in halves. This is identical with one recorded by Professor Douglass and myself in Arequipa in 1892. It leaves Euxinus in latitude +27°, and appears to coincide with Lowell's unnamed canals 659 and 660, which, however, he placed about 250 miles farther south. He considered them to be *novas,* by which he said he meant a canal "which has had no previous existence." He gives an interesting account of them in *Lowell Bulletin,* No. 45. In the light of our observations, it or they, if there are really two of them, are properly speaking seasonal canals of short duration. Hephaestus and Eunostos-Cyclops were fairly narrow.

The northern hemisphere is now turned slightly towards us some 2° to 5°. This only occurs once in 15 to 17 years in the northern midwinter, and so gives us an opportunity to study the northern snow cap during its formative period. The melting of the caps on the other hand is always well seen, as they are then turned towards us when the planet is near opposition. Mars is now having its maximum warmth at the southern pole and its maximum cold at the northern one, and we can watch the water distilling from the southern hemisphere and beginning to condense and freeze at the northern cap. The latter began this year to increase perceptibly in size after this date.

The statement is made in a very excellent astronomical text book, that "at the Martian solstices the cap in the winter hemisphere is very large, often extending halfway from the pole to the equator." This statement was clearly made not as the result of anybody's careful investigation of the matter, but simply because it seemed plausible, and ought to be the case anyway. The only trouble with it is that it is quite untrue. We may say at once that such a statement would require a considerable number of observations to substantiate it, and would better not have been stated in such a positive manner unless it could be proved. Doubtless the temperature at the winter pole of the planet is low enough to freeze water, but the difficulty apparently is that there is very little if any water there to freeze. The water does not begin to arrive in quantities from the other pole until several weeks later. We can never see either pole at its winter solstice because the sun does not illumine the planet at that time beyond latitude 66°. Probably if there were a snow-cap, and it extended as far as latitude 60°, we should see it. In Table I we give the record of two drawings in each of the four years that have a bearing on this question as far as the northern polar cap is concerned. The northern winter solstice occurs in ⊙ 270° on M. D. December 12. The last column of the table gives the central latitude as seen from the sun.

TABLE I.

THE NORTHERN POLAR REGIONS OF MARS.

Date		ω	⊙	M.D.	d	D_E	D_S
1913 July	27	180°	290°.6	Dec. 44	6″.2	−10°.0	−22°.3
Aug.	6	92	296.6	Dec. 54	6.5	− 7.5	−21.3
1924 Oct.	5	0	269.7	Dec. 11	18.8	−18.2	−24.0
	12	330	274.1	Dec. 18	17.5	−19.0	−23.9
1926 Aug.	18, 19	261	266.6	Dec. 6	13.2	−15.3	−24.0
	27, 28	230	272.5	Dec. 16	14.2	−14.1	−24.0
1928 Oct.	5, 6	9	321.5	Jan. 41	10.4	+ 2.4	−14.6
	8, 9	294	323.4	Jan. 44	10.6	+ 2.8	−14.1

In 1913 and 1928 the drawings described are the earliest ones that we have. The only ones that show any trace of a snow cap at all are the third, and the last two. The case of the third is a curious one. The last previous reference to a cap is on September 22. On that date and on October 1 one is shown having a visible diameter of 30°. On October 3 it suddenly grew quite large, reaching latitude +60°. Two days later,

at the time of the solstice, it was so small as to be described as "practically invisible." It would appear to have consisted either of cloud or of a thin layer of hoarfrost. It was glimpsed two or three times again when very small but was not steadily visible until November 8, ⊙ 290°.7, after which it rapidly increased in size. On October 5, 6 of the present year it appeared probably as a great mass of cloud, but in the last observation recorded in the table it was undoubtedly snow, reaching apparently to latitude +70°. Since then it has been rapidly increasing in size, but it is thought will not much surpass its present dimensions. It now, November 8, M. D. February 17, reaches latitude +50°, and is expected to remain near that figure until the equinox, which occurs on Martian March 1. We thus see that the Martian polar caps behave much like the terrestrial ones. In the light of these observations a further statement in the text book that "the northern one (cap) never quite vanishes" would seem to require modification.

October 16, 17, ω 207°.5, ⊙ 327°.7, *d* 11″.2. A faint, indistinct shading 1000 miles in diameter was seen in the place of Charontis. This was confirmed six months later, when it appeared a little darker, and a faint broad hazy canal, Tartarus, connected it with Titanum. The seeing on this latter night was 10, the best yet, and a slight darkening was for the first time detected bounding the northern cap, which had increased materially in size, being now estimated at 2000 miles in diameter. No visible clouds have been detected in its vicinity. The increase might therefore be attributed either to frost, to snow deposited from clouds formed at night, or from invisible daylight clouds. The yellow south polar cap was now clearly brighter than the deserts, indicating that it had risen higher in the dense Martian atmosphere. On only one previous occasion had it been recorded as brighter.

October 27, 28, ω 117°.9, ⊙ 333°.6, M. D. February 6, *d* 12″.2. A very faint rounded dark area 1500 miles in diameter is central over Lowell's Nodus Gordii. The following night the north preceding portion of this had darkened, and was connected with the northern cap by a faint band from 500 to 1000 miles wide, still more faintly seen the previous night. The inclination of this band to the meridian indicated that the clouds which had presumably deposited the moisture were travelling northerly. On both these nights the southern cloud cap had diminished in a striking manner.

October 29, 30, ω 92°.1, ⊙ 334°.7, *d* 12″.4. The southern cap has increased notably in size, and the dark border of the northern one is quite pronounced, implying that the seasonal melting, begun at about ⊙ 33°, is now well under way. Solis is near the central meridian, dark and elongated, in a more or less meridional direction. A similar but much smaller spot is now seen at the preceding end of Sirenum. This was not detected two days earlier when it should have been located on the central meridian, seeing 9. It was confirmed four days later.

November 1, 2, ω 67°.2, ⊙ 336°.3, *d* 12″.7, Martian Date February 11.

Striking detail appeared tonight. Aurorae, Lunae, and Solis appeared as three dark spots, the first two quite round, and each about 500 miles in diameter. Chrysorrhoas was clearly seen, Ganges was tremendous, dark, and 500 miles in width, while a somewhat lighter canal 400 miles wide joined Aurorae and Solis, thus completing the triangle. All three canals were convex outward. Nilokeras was also strongly marked, leading to a large darkened area near Acidalium. The southern cloud cap had again increased markedly, extending on the sunrise limb to 15° north of the equator, but reaching to only —60° on the side of the terminator. Two position angles were taken of Solis when near the central meridian, giving it an inclination 37° ± 3°. This was surprising, because in 1926 all the better drawings showed it as elongated in a meridional direction, when not circular. It therefore became important to check this result.

November 2, 3, ω 92°.4 and 100°.5, ⊙ 336°.8, *d* 12″.8. The first series of six measures was taken with Solis on the central meridian, and gave an inclination of 37° ± 4°. The second set of four measures taken half an hour later gave an inclination of 40° ± 2°. The two sets therefore confirmed that of the previous night, and show that Solis is now elongated in general along the course of Eosphoros. The length of the darkened area at present is about 1000 miles, and its width half as great. It would therefore stretch one-third way across the American continent. Such a change as this since 1926 can obviously only be due to vegetation, but even then it certainly cannot be laid to accidental natural causes. These might have scattered it in various directions, but could hardly have kept it together, and swung it or built it out at an angle of 40°. It would certainly seem to imply purposeful and intelligent control, and furthermore an intelligence and efficiency not to be expected in the lower animals, but quite comparable to our own. I see no reason to despise the Martians as "only lower forms of life."

November 3, 4, ω 31°.3, ⊙ 337°.4, *d* 12″.9. The expected green in the maria appeared for the first time. It was still faint, but undoubted, and in a few weeks will be distinctly more intense. All the region between longitude 15° and the terminator was covered with thin mist, through which the outlines of the maria could only faintly be seen. The greens are most marked in the Martian months of February, March, April, July, and November. Since the maria lie mainly in the southern hemisphere, this means that the greens appear chiefly in the early autumn and also in midwinter and the late spring of that region. The second period certainly sounds paradoxical, until we recall that the maria lie mainly in the torrid zone, where the fluctuations of temperature from day to day are very slight, and as we have shown in former Reports are not likely even at night to fall much lower than is the case on the earth. On a planet whose temperature is as uniform as it is on Mars, it must be further noted that it is presumably not a question of temperature at all, but a question of water, and it so happens that the first and last periods

are just the seasons when the polar caps are melting most rapidly, and the water is being transferred across the planet from pole to pole. Why we should find green areas in July is not clear, but they have been recorded and crayoned at two different apparitions. For most of the Martian year the maria are a colorless gray.

Acidalium, the largest of the Martian polar swamps or "tundra," appeared on this date for the first time. Its meridional length is 600 miles, and it is expected to increase rapidly during the next few nights. The latitude of its center is now 60° north, and its temperature due to the melting snow 32° Fahrenheit. This latitude is identical with that of central Hudson Bay on the earth, and the Martian date February 13 corresponds to our February 25, since it is not possible to make the Martian and terrestrial dates exactly correspond throughout the year, as is explained in Report No. **10**. I believe that if Hudson Bay were to become free of ice on our February 25, the residents of that vicinity would be surprised. This is mentioned merely to illustrate the point, previously made in several of our Reports, that the climate all over Mars is much more uniform than it is on the earth, and also, excepting near the equator, much warmer. Its uniform warmth furnishes one of a series of arguments in favor of a dense and extensive Martian atmosphere.

PRIVATE OBSERVATORY, MANDEVILLE, JAMAICA, B. W. I., NOVEMBER 8, 1928.

THE MEAN PERIOD OF THE SUN-SPOTS.

By WM. A. LUBY.

(Continued from page 544.)

For the whole period of 50 years Staudacher observed a total of 1136 days or six per cent of the time. For the first 25 years he observed the sun on 856 days or an average of 34 days per year. For the last 25 years he observed the sun 271 times, an average of 11 days per year. His observations were irregular, infrequent, and unsystematic. In only one year did he observe the sun as many as a hundred times. Four different years he observed the sun only one day each. Now it is imperative to avoid any inference that when days of observation are few, spots are few and vice versa. And at the very least it is difficult to exclude wholly the effect of this idea in handling spot-free days, estimating probabilities, and fixing epochs of maximum and minimum.

In an early number of the Mittheilungen Wolf has summarized the data then known and fixed the following periods counting from minimum to minimum:

Fifteenth Period	(1755.56-1766.67)
Sixteenth Period	(1766.67-1777.76)
Seventeenth Period	(1777.78-1788.89)
Eighteenth Period	(1788.88-1800.00)

When he gave those summaries Wolf had fixed the mean spot period at about 11.1 years and had determined how many cycles there were back to the days of Father Scheiner. He then discovered the data of Staudacher. Though these spot counts cover half a century they actually do not indicate any particular period. They were, however, fitted into a scheme of things in which the period was already fixed and the epochs were already largely determined. A later revision by Wolf exhibits some changes of epochs from minimum to minimum partly due no doubt to the data of Staudacher.

Fifteenth Period	(1755.2-1766.5)
Sixteenth Period	(1766.5-1775.2)
Seventeenth Period	(1775.5-1784.7)
Eighteenth Period	(1784.7-1798.3)

Three dates are here changed but the period remained the same. Yet the best set of observations preceding Schwabe was discovered between the date of fixing the first four minimum epochs and that of fixing the last four.

The serious defect in such observations as Staudacher's is that they are not evenly distributed. If he had observed during the first 25 years not 34 days as a yearly average but 34 days per year distributed at equal intervals something approaching certainty could then be arrived at. As it is, Wolf is compelled to deal with probabilities,—"Spots per Observation." For 1750 this number is larger than for 1749 and 1751. Hence a maximum is placed at 1750.3. A totally different date might have been the result if Staudacher had begun his counts in 1747. In 1753-1758 inclusive there were 38 observations—six per year. Were spots few or was the observer indifferent? Again in 1774-1777 inclusive there were 9 observations. Were spots really infrequent? Yet out of those observations we have two 8 year periods. Three maxima, 1761.5, 1769.7, and 1778.4 give periods of 8.2 years and 8.7 years respectively. Always the process is the balancing of slight probabilities against other probabilities equally slight and the whole against a previously determined mean spot period of 11.1 years which was itself dependent on probabilities of the same type.

6. Many eminent astronomers have questioned the epochs fixed in the latter part of the eighteenth century—the period covered by Staudacher's infrequent observations. The long "17 year" period which according to Wolf runs from 1788.1 to 1804.2 (according to Wolfer it runs from 1788.1 to 1805.2) has been questioned. Loomis and Young believed a maximum should be between 1788 and 1805.

> "It is even doubtful as has been said before whether there should not be recognized an additional maximum in 1795 over and above those enumerated by Wolf." (Young, The Sun, p. 155.)

Newcomb (Astrophysical Journal 13.1) made a careful mathematical analysis of the spot data and a determination from it of the mean spot period. Pertinent comment on the point in question is there given:

"It would seem from what precedes that a revision of the conclusions to be drawn from the observations of sun spots for the interval 1775-1790 is very desirable."

Again:

"More remarkable yet is the acceleration about 1790, which, it will be seen, seems to affect all the phases. But, again, during the following two or three decades this acceleration is changed to a retardation. I was at first disposed to think that these perturbations of the period might be real, but, on more mature consideration I think they are to be regarded as errors arising from the imperfection of the record."

Further, Newcomb says:

"The contrast between the sudden deviations in the residuals of doubtful period and the small ones of the recent observed epochs makes it almost certain that the errors between 1770 and 1800 are due to imperfections of the record."

Now "two or three decades" after 1790 carries to 1810 or 1820. This with the interval "between 1770 and 1800" gives a total interval of 40 or 50 years for which the epochs of maxima and minima are very doubtfully placed. Thus according to Newcomb, one extremely short period and the long 17-year period are fixed in an interval characterized by "errors arising from imperfections of the record."

Wolf's summary of the period 1788.88 and 1800.0 which follows is illuminating as it shows clearly how scanty, contradictory, and uncertain is the evidence which he was compelled to sift.

"The eighteenth period (1788.88-1800.00) was not so abundant in spots as the seventeenth. For 1789 and 1790 observations are lacking; on the other hand, according to Bode (Sammlung Astr. Abth.) and Brandes (*Astronomie in Briefen*), Schröter and Herschel observed large spots in 1791 and 1792 so that there was then perhaps a maximum. As early as 1793 Bode and Schröter (*Berl. Jahrb.* 1797) saw the sun free of spots on several days."

"Flaugergues enumerates (*Berl. Jahrb.* 1799, Connaissance des Temps, 1798-1804): 17 days in September, 1795; 13 days in March and April 1796; 95 days, 1797; 141 days in 1798; and in 1799 as many as 230 days as free of sun spots, and adds that not until the end of October, 1800, did the sun spots appear again more frequently. The report of Von Eude (*Zachs Corresp.* 24) that he had seen many large sun spots from 1794-1802 almost uninterruptedly, does not agree very well with this. However, Fritsch (*Berl. Jahrb.* 1802 and 1803) saw in 1798 and 1799, to be sure at single times, very fine groups, but then again for months he saw not a single spot, although the best weather conditions prevailed; "similar single observations by Kohler, Herschel, etc. confirm those by Fritsch, and there seems to have been a minimum about 1798 or 1799."

7. Turning now to the period previous to 1749 it is found that no spot counts are known to exist. Observers did record remarks on the presence or absence of spots over certain intervals. Scheiner, who according to A. S. D. Maunder should be credited with the discovery of sun-spots rather than Fabricius or Galileo, left a record of a long series of systematic observations and wonderful drawings of the sun. Wolf fixed the maximum of 1626.0 by Scheiner's observations. (Wolf's *History of Astronomy,* page 569). Scheiner, however, was profoundly interested in the period of the sun's rotation and many beautiful cuts in his Rosa Ursina show the passage of spots across the sun's disc. But Scheiner had no conception of periodicity in the spots themselves and made his observations on them with a wholly different purpose in mind. He did, however, observe and record the fact that spots in the higher latitudes rotated more slowly than spots in the lower latitudes. The significance of this remained unnoticed until Carrington and Spoerer over two centuries later re-established this fact.

A summary of over a hundred years in the interval under consideration is given by A. S. D. Maunder as follows:

> "But neither Scheiner nor any of his successors seem to have had any suspicion that the changes in the solar spots proceeded as a series of undulations. The reason for the delay in the discovery of what we now know as 'the sunspot cycle' was simply that it does not seem to have been working in what now we should consider its normal manner, and before the middle of the Seventeenth Century the supply of sunspots would seem to have run out.
>
> "For the first years after the discovery of sunspots in 1610, the sun was fairly active; we do not know for certain whether a maximum took place about 1610, but the first minimum noted was in 1619 and it was followed by a well marked maximum in 1625 (Wolf and Wolfer say 1626). The next minimum fell in 1634, and was followed by a maximum in 1639, 14 years after the preceding maximum. Then there was a long quiet period with a 'maximum' in 1650, which consisted of but a few spots. Spots were seen in 1654 August 12; 1655 February 9-21; 1660 April 27-May 9; in 1661 two small groups and then again none at all until 1671. From this date until the end of the Century, spots were very occasionally observed, and after 1715 spots were frequent and by 1718 there was a decided maximum. The long dearth of sunspots lasted from 1645 to 1715, or 70 years, and during this time, so far as we know, there were no spots large enough to be seen bythe naked eye; all required the use of a telescope." (*Splendour of the Heavens,* Vol. I, pages 113-4.)

This sounds like a resumé of sun-spot history based on a very fragmentary record. From the certain behavior of the sun during the last 100 years it is difficult on reading this and other summaries of the "seventy year period of quiescence" to avoid the conclusion that here the trouble is dearth of observations and not dearth of spots. The

impenetrable mystery in which the cause of the sun-spots has been hidden has, where actual knowledge ceases, permitted to the improbable some measure of probability.

The uncertainty of the spot record previous to 1749 is strikingly emphasized by E. W. Brown in the *Monthly Notices,* Vol. 60, page 599:

> "In the period before 1750, represented on the upper part of the plate, one must regard Wolf's results with considerable doubt. A maximum was sometimes inferred from the mention of a big spot on the sun easily visible to the naked eye; such a spot has occurred during the minimum now in progress, and therefore one can hardly regard the deduction of a maximum from a big spot as very trustworthy. In fact Wolfer rediscussing Wolf's results gets in one part two maxima and one minimum where Wolf had found only one maximum. Again it is not easy to decide on what principle (e. g. by the number of spots visible in a given time, or by the spotted area) the sun spot curves should be formed. The hump which is visible in several cases on the descending slope may possibly come out a real maximum by another method of reckoning. In fact the curve gives an appearance of definiteness which disappears when the observations are more closely examined. . . Wolf says there is a probable error of about two years in the date of each maximum before 1750; an error of four years in each of the cases is not improbable."

The general conclusion concerning sun-spot observations for the 216 years preceding Schwabe is that most of the epochs of maxima and minima are involved in very deep uncertainty by reason of the scarcity and the character of the observations during that interval. In the very nature of the case this was well-nigh inevitable for the conception of periodicity in the sun-spots had not occurred to any observer before 1826 hence before that date no one undertook the systematic observations necessary to determine epochs and period. Consequently the epochs of maxima and minima previous to 1826 and the accepted mean period seem to be a matter of probability. To determine the mean period with exactness systematic observations over a long period are necessary. Actually the accepted mean period has been determined from 216 years of uncertain and unsystematic observations combined with less than 100 years of certain and systematic ones.

8. The effect of errors in fixing epochs of maxima and minima upon the mean period can readily be seen by inspecting the usual method of determining it which follows.

Minimum to Minimum		Average Interval
1610.8	1913.6	11.22 years
1755.2	1913.6	11.29 years
Maximum to Maximum		
1615.5	1917.6	11.19 years
1750.3	1917.6	11.15 years

This gives a mean interval of 11.21 years.

Here two critical minima and two critical maxima which are used depend on the old observations. Upon them also depend the epochs of maxima and minima for the 210 years from 1610 to 1826. These epochs help determine the number of cycles which is the divisor used in the table above. Considering the character of these observations over this long interval the likelihood of error is extremely great. It is clear that the "seventy year period of quiescence," the later interval criticised by Newcomb, and the "inference of a maximum from one big spot," leaves the value of the mean period above only a small measure of probability.

9. Turning now to the reliable data since 1826, we find that the mean spot period from 1828.5 to that of 1917.6 is 11.1 years. This is close to the older value but we do not know positively that the maximum of 1828.5 was a primary maximum. The Solar Physics Committee places the next maximum after 1828.5 at 1836.5 not at 1837.2. This is based on Schwabe's spot counts and drawings. The mean spot period from 1836.5 to 1917.6 is 11.59 years.

If we take the interval from the minimum of 1833.9 to 1923.5 it gives a mean of 11.2 years. The first minimum may have been exceptionally delayed. Certainly the last minimum was unexpectedly early. The interval between the minima of 1844.0 and 1923.5 gives a mean of 11.36 years. The mean of 11.1, 11.59, 11.2, and 11.36 is 11.31 years.

The mean period long accepted was 11.1 years. The maximum of 1917.6 raised this, as we have seen, to 11.21 years. The modern observations considered alone indicate a value greater still.

10. We may conclude that in spite of all the work that has been done on the old observations the correctness of the mean period they have helped to determine seems to be more than doubtful. The reliable observations since 1826 indicate that the period is 11.31 years or more. Moreover, the long "17 year" period seems far from being certainly established. Also the short 7.3 year period and the corresponding dates of maxima clearly seem to be incorrect.

THE STUDENTS' ASTRONOMICAL LABORATORY OF HARVARD UNIVERSITY, 1903-1928.

By HARLAN T. STETSON.

Twenty-five years ago there was started at Harvard University by the late Robert Wheeler Willson what was then a somewhat novel experiment in the teaching of astronomy,—a students' astronomical laboratory. It was founded primarily for instruction in astronomy and its applications by laboratory methods akin to the laboratory practices for the sciences of physics, chemistry, and biology. Like most new departures in methods of teaching, the laboratory methods in astronomy which Professor Willson inaugurated were for a time misunderstood. With a growing appreciation, however, of the inductive method in teaching and the idea that the individualized laboratory problem was a challenge to the student's ability to analyze and constructively think his way through to a logical conclusion, a fairer estimate of Professor Willson's growing vision came to be realized. His advice and simplified apparatus for individualized instruction came to be sought by teachers of astronomy elsewhere. Today so many teachers are using devices and methods whose origin goes back to the beginning of this laboratory that it seems appropriate to mention here the early interests of Professor Willson which directed him to devote his life and much of his means to the teaching of astronomy.

Trained in the schools of Salem, in constant association with the life of that historic port, he early exhibited a fondness for things nautical which he kept through life and which, later in his career, was to lead his attention to the application of astronomy to navigation and the development of instruments and methods to make clear the teaching of these closely allied subjects. In 1869 he entered Harvard at the age of sixteen, in 1873 he graduated with his class, receiving highest honors in science. He spent the first year after his graduation with Dr. B. A. Gould at the Argentine National Observatory in South America. The following year he returned to Cambridge to become assistant in the Harvard Observatory, then under the direction of Joseph Winlock, and also served as tutor in physics from 1875 to 1881.

After a period in Germany for further study he received the degree of Doctor of Philosophy from Wurzberg in 1886 and returned again to Cambridge, where he collaborated with Benjamin O. Peirce in publishing numerous investigations in physics. When in 1891 the opportunity came of teaching in his chosen field, he immediately began to build up substantial courses in astronomy. With the rapid spread of laboratories of physics, chemistry, and other sciences, Professor Willson visualized

a laboratory for astronomy, and he was a pioneer in devising apparatus and methods which should do for the student of astronomy what laboratory work in other fields was doing for the allied sciences. With meager accommodations, he built up his equipment, adapting it as needs be to crowded classrooms, while searching for more commodious quarters.

The erection of Robinson Hall brought emancipation to the Department of Architecture and left vacant an old, historic frame building which had originally housed the museum of Louis Agassiz. Through its various meanderings about the college grounds it had served, in turn, as college hospital, the home of the Hasty Pudding Club, and headquarters for the Architectural Department until 1903, when the present Students' Astronomical Laboratory on Jarvis Street was established therein with Professor Willson in charge. The same year Willson was appointed full Professor of Astronomy.

While most interested in students who specialized in astronomy, Professor Willson never forgot the attention due the larger group whose passing interest in the subject merited the best that could be offered. As a teacher he gave of his time unstintingly to clarify the more obscure parts of his subject and was a master genius in the development of apparatus to demonstrate in a moment the more puzzling aspects of astronomy. It was his constant desire not only to provide the best of equipment for laboratory instruction at Harvard, but also to have such material and methods available for courses elsewhere. Other institutions, recognizing merit in his novel methods, began to introduce more laboratory work in astronomical instruction, and today thousands of pieces of apparatus of his design dot the classrooms in astronomy literally the world around.

From his own private resources he rebuilt a large part of the main building to provide adequate observing facilities on its roof, and in addition erected shelters in the adjoining yards for instruments he privately purchased. Later (1906) he donated this equipment to the University to be devoted to the instructional purposes in astronomy. In 1919 Professor Willson retired from active service and was appointed Professor Emeritus. After a brief illness he died in November, 1921.

As a result of his efforts, the courses of instruction in astronomy which he founded have continuously been carried on, modified and enlarged to meet the changing and growing needs of a rapidly developing science. Thousands of students have passed in and out of the Jarvis Street building with a new sense of wonder and appreciation for the natural order about them, and not a few, guided by early interests, have followed the subject into the fields of applied astronomy and into the making of an astronomical career.

The interest in applied astronomy was fostered by the period of the War and the War program of the University in which the Astronomical Laboratory shared. During the year 1917-1918 some 500 students were

given instruction in the application of astronomy to navigation and aviation in connection with the War courses of the University. This form of instruction was carried on simultaneously with, but quite independent of, the work of the Government naval schools established in other College buildings near the Yard, where the courses of instruction were not under control of the Faculty.

The interest in the applications of astronomy thus engendered has persisted in post-War years and continuation of the courses in nautical astronomy appears to fill a much needed demand. When in the fall of 1927 the Government chose to establish at Harvard one of the five widely distributed R. O. T. C. units of the Navy to be maintained within the colleges of our country, the equipment of the Astronomical Laboratory, through close coöperation with the Naval Science Department, made possible an effective organization of navigation instruction which quickly made Harvard a recognized leader in the establishment of systematic instruction among the several naval units.

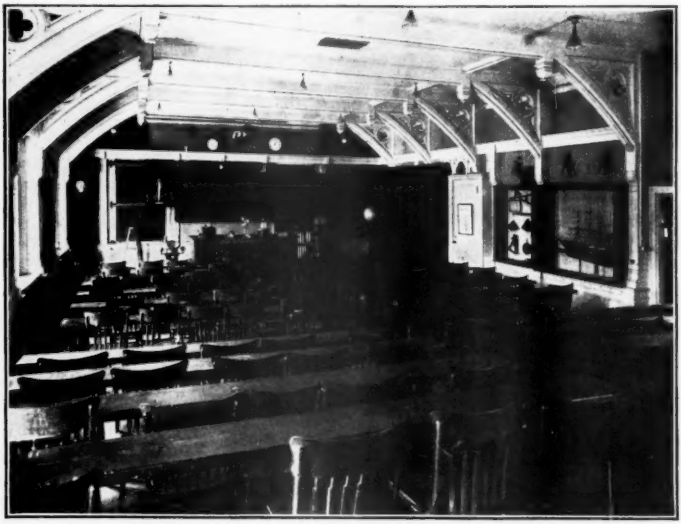
As the naval course, however, by the Government stipulation can be open only to freshmen, and to freshmen who propose to take the entire four-course naval program, the regular course in nautical astronomy (Astronomy 2a) will continue to be given, as the two somewhat parallel courses necessarily fill entirely different needs and extend, rather than duplicate, the opportunities of instruction in the field involved.

While the Harvard College Observatory was founded primarily for research in all branches of astronomy, the Laboratory, founded primarily for the instruction of students, has centered its interests upon the teaching of astronomy and its allied branches, and has regarded as its chief concern improvements in the methods of instruction and the enlargement of facilities for making even more adequate its presentation not only to professionally inclined young men but also to those whose major interests lie in other fields and whose only glimpse of the scientific habit of thinking will come through the beginning course. On the other hand there is no attempt to make the beginning course so called "popular." Harvard is one of the larger institutions where astronomy is recognized as fulfilling the requirements for a laboratory course in science, as is universally accorded physics, chemistry, or biology. More and more, the student is being placed upon his own, and encouragement offered for the pursuit of work of distinction for its own sake.

In 1920-1921 provisions were adopted by the Faculty for granting the A.B. degree with distinction (or as we now say, with honors) in astronomy and allied subjects, and in 1921-1922 astronomy was first included in the list of subjects approved for the degree of Doctor of Philosophy. The introduction of advanced research courses in astronomy, some of which have been given at or in coöperation with the Observatory, have made possible the affiliation of work at the Laboratory and at the Harvard College Observatory with the work in the Graduate School of Arts and Sciences. For advanced research in astronomy, the material

and facilities of the Observatory, under the able directorship of Professor Shapley, offer opportunities that place Harvard in the front rank of institutions offering graduate work in astronomy.

It is needless to emphasize the importance of maintaining research in connection with the teaching of the subject. In addition to specific problems of investigation carried on at the Laboratory, the Laboratory has coöperated with the Observatory and other institutions in the securing of astronomical data, particularly with respect to solar and photometric investigations. With but few exceptions, the assistants at the Laboratory in recent years have been enrolled candidates for higher degrees in the Graduate School of Arts and Sciences and have given



THE LECTURE ROOM OF THE HARVARD ASTRONOMICAL LABORATORY.

The room is especially equipped for demonstration lectures in descriptive and applied astronomy. Direct and alternating current, gas, compressed air and automatic controls for darkening the room are provided at the demonstration desk.

half-time to courses of instruction or research and half-time to teaching. The teaching assistantships afford not only some financial remuneration to the individual concerned, but, what is of lasting importance to those aspiring to professional positions, afford opportunity for training and experience in systematic astronomical instruction so indispensable to the professional worker whose abilities and inclinations may lead to instructional positions as well as observatory work.

A brief description of the laboratory equipment as it exists today may be of interest. The first floor contains an elementary laboratory and a

computing room provided with astronomical clocks of the highest grade, chronographs, and an up-to-date electric computing machine. On the second floor is a lecture room with a seating capacity of 140. A large lecture table is designed especially for purposes of demonstration. Electrically operated window shades darken the room for lantern projection and for demonstration purposes. Controls of the window shades and room lights, outlets for alternating and direct current, gas, compressed air, and a time signal circuit are available at the demonstration desk.

For the courses in navigation and nautical astronomy, there are provided sextants, an eccentricity tester, chronometers, peloroses, a ship's compass with compensating binnacle, a gyroscopic outfit for a study of the gyro-compass, a collection of charts, and numerous minor pieces of apparatus.

A platform on the roof serves for constellation study and observations with the sextant and other portable instruments. In separate shelters in the yard adjoining the main building are a Clark Equatorial of 7½ inches aperture, a 4-inch Meridian Circle, a 4-inch Clark Equatorial, a 3-inch Transit with zenith level by Fauth, and a transit house with three 3-inch transits and chronographs all in electrical connection with a time service switchboard in the main building. These are chiefly used by advanced students, but the Equatorials are used for studying objects of interest by students in descriptive astronomy, and on some occasions are open to the public.

For the work of the advanced courses are provided: a filar micrometer, an equalization wedge photometer, spectroscopic apparatus, a Gaertner comparator for the measurement of spectrograms, and thermoelectric photometers for the measurement of photographic plates. The basement of the main building contains a well-equipped machine shop for the construction of apparatus for instruction and research, a photographic dark room, and an instrument room especially equipped for investigations in photographic photometry.

The Laboratory has a specially selected working library including the leading astronomical journals and observatory publications.

In addition to the teaching of descriptive and applied astronomy, including the courses in navigation, the laboratory's chief contributions to astronomy comprise the systematic observations of occultations, an intensive photometric study of the minima of certain classes of variable stars, researches in photographic photometry, the daily photography of the sun, and the preparation of sun-spot data in coöperation with the Mt. Wilson, Yerkes, and the Naval Observatories, and investigations on the nature of the solar corona. The Laboratory has participated recently in research programs of eclipse expeditions in 1923, 1925, 1926, and 1927, either on its own account or in coöperation with other institutions.

In 1923, our party coöperated with the McCormick Expedition, locat-

ed at San Diego and Lakeside, California, under the direction of Professor S. A. Mitchell. The program was chiefly devoted to the flash spectrum photography with concave gratings. Clouds completely obscured the sky at San Diego, but partially revealed the corona at Lakeside.

In 1925, the Harvard Laboratory party went to Middletown, Connecticut. Clear skies made possible the successful carrying out of a program to measure and analyse the radiation of the corona by means of a vacuum thermocouple and water cell. The shadow bands were also first successfully photographed at this eclipse, our success in this part of the program being largely due to the ingenious extra focal camera devised for the purpose by Professor A. E. Douglass of the University of Arizona. The party consisted of Dr. and Mrs. W. W. Coblentz, of the U. S. Bureau of Standards, Mr. Kenneth Gell, Mr. D. W. Mann, Mrs. Stetson and H. T. Stetson in charge. Results of the expedition have appeared in the *Astrophysical Journal, Scientific Monthly* and elsewhere.

In 1926, a somewhat more ambitious program was undertaken, an expedition going to Benkolen, Sumatra, to observe the radiation of the corona, and to make a photometric study both with photographic and with visual photometers of the total light in the corona and to determine its color index. The results were successful so far as photometric observations were concerned but high humidity and light cirrus interfered with radiometric measurements. The expedition consisted of H. T. Stetson, in charge, Dr. W. W. Coblentz, Physicist at the Bureau of Standards, Mr. Weld Arnold, astronomer of the American Geographical Society, New York, and Mr. W. A. Spurr, now assistant in Astronomy at Harvard. The instruments transported included a 20-inch reflecting telescope with driving clock, vacuum thermocouples, galvanometers and accessory apparatus, a Macbeth illuminometer, a King photographic coronal photometer, and a silvered quartz lens camera for photography of the ultra violet. Results of the expedition have been published in the *Astrophysical Journal* and elsewhere.

In 1927, the Harvard Laboratory was represented by Mr. and Mrs. Stetson and Mr. George McM. Godley of New York, who coöperated with the McCormick-Chaloner party of the Smithsonian Institute in a combined program for spectroscopic and photometric observations at Fagerness, Norway. Complete cloudiness at the hour of totality prevented results.

More recently investigations have been carried on at this Laboratory in the measurement of radio reception as a concomitant factor in sun-spot variation. A self-recording super-heterodyne receiver has been installed by Dr. Greenleaf W. Pickard, of the Wireless Specialty Company, which makes it possible to continue a quantative series of measurements throughout the present sun-spot maximum. A correlation of signal strengths received nightly from WBBM with the degree of

spottedness of the sun's surface appears so unmistakable from present data that there seems little room for doubt as to the reality of the connection. More specifically, in many instances the large fall in the intensity of the signal wave as received at the laboratory has been observed with the passing of a single sun-spot across the center of the solar disk. It seems likely that exceptions may in general be explained when the magnetic character particularly the resultant polarities of the components of groups are taken into account.

Photoheliograms are measured with great facility at this laboratory by a modified form of the projection method originally employed by Hale. Details of the Harvard scheme have already been published.

A new device for measuring sun-spot area has just been built in the instrument shop which it is believed will materially aid in the measurement of the total degree of spottedness of the sun on a given day. Further study may well lead to the adoption of an improved index for solar activity to replace the somewhat unsatisfactory "Sun Spot Numbers" so long in use.

Numerous gifts of special apparatus and funds or grants for research and assistance have been received from time to time from various sources. The largest single gift affecting the laboratory is the recent bequest of the late Annie Downing Willson, leaving in trust in memory of her husband, the sum of one hundred and fifty thousand dollars, the net income from which is to be paid to Harvard College under the terms of the will "to support a professorship of applied astronomy including navigation at the College itself as distinguished from the Astronomical Observatory." In Mrs. Willson's words "This gift is made by me to carry out a very earnest desire and wish of my husband that applied astronomy for the benefit of many students may continue to be taught at Harvard as heretofore by him. This professorship is to be called and known as the Robert Wheeler Willson Professorship of Applied Astronomy. The teaching by such professor shall be done for the most part by laboratory methods and not by lectures. In case the income from said fund shall be more than sufficient from time to time to pay the salary of the said professor of applied astronomy, the balance of income shall be expended towards the maintenance and equipment of the astronomical laboratory where applied astronomy is taught."

With such an endowment, Mrs. Willson believed she could adequately carry out her husband's wishes to have established a teaching professorship which should recognize that same respect and reward for the creative spirit expressed in instruction as is so often recognized in the research worker alone.

To further commemorate Professor Willson's devotion to the teaching of astronomy, three surviving sisters have just now established a Robert Wheeler Willson Memorial Scholarship Fund in applied astronomy, the income from which is to be used for the assistance of deserving students who shall elect to study applied astronomy at the Harvard

Astronomical Laboratory as the major subject of interest and who by high standing in astronomy and its allied subjects, mathematics and physics, has exhibited unusual promise and aptitude for his chosen field.

During the past quarter century of the laboratory's existence, some fourteen different courses have been offered from time to time in the subject matter of astronomy and its applications. During the same interval more than four thousands of students, undergraduates and graduates, have been enrolled in courses at the laboratory.

Those making use of the subject professionally are to be found scattered here and there in schools, colleges, and observatories throughout the world, some teachers, others investigators, and still others penetrating the arctic or the tropics and surveying unknown regions by reason of training gained from laboratory courses in astronomy.

STUDENTS' ASTRONOMICAL LABORATORY, HARVARD UNIVERSITY, JULY, 1928.

AMERICAN ASTRONOMICAL SOCIETY.

ABSTRACTS OF PAPERS

ALPHA AND PROXIMA CENTAURI.

BY HAROLD L. ALDEN.

From twenty-three plates, of which the central portion, two inches in diameter, had been desensitized with copper sulphate, the parallax of the brighter component of α Centauri was found to be $+0''.762 \pm ''.009$. That of the fainter is $+0''.747 \pm ''.009$. From another set of twenty-three plates the parallax of the faint companion Proxima, distant more than two degrees from Alpha, was found to be $+0''.783 \pm ''.005$, thus confirming the fact that this faint companion is somewhat nearer than Alpha itself and is the nearest known stellar object. The proper motions of the two components of Alpha were determined in the two-year interval covered by the plates. These differ because of orbital motion and enable us to determine the relative masses of these two stars. On the assumption that the four comparison stars are on the whole not affected by any common proper motion except that due to parallactic drift, the mass of the fainter component is 0.86 of the mass of the brighter, in good accord with the value derived by Lewis Boss from a discussion of the meridian observations.

APPLICATION OF THE HOLLERITH CALCULATING MACHINE TO THE LUNAR TABLES.

BY E. W. BROWN.

An informal account of some new methods of adapting calculating machines to the computation of Ephemerides.

PRELIMINARY DISCUSSION OF THE HARVARD CATALOGUE OF LONG PERIOD VARIABLES.

By Leon Campbell and Annie J. Cannon.

The material assembled in the *Harvard Catalogue of Long Period Variables,* recently published, has been used for a somewhat detailed discussion of certain characteristics of these stars, such as frequency of period and the relations existing between spectrum, period, range of variation, and magnitude at maximum. Periods have been assigned to nearly 1100 of the variables in the Catalogue, for one-half of which the spectrum is known.

A preliminary study of the data indicates that—

The maximum frequency of period for all the variables is around 300 days.

No correlations are definitely established for those stars whose spectra are without emission lines.

For the stars having spectra of Class Me—with emission lines—the relation, already known, between increasing period and advancing spectral class is more definitely established from the larger amount of material. When the period of a star is less than 200 days, the spectrum at maximum is most likely to be not later than M2e. Periods of 300 days cluster about a spectrum of class M4e or M5e, and for periods greater than 300 days, the spectrum is more likely to be of class M6e or M7e. In nearly all cases, when the observations extend over a considerable variation in the star's light, the spectrum changes to a later sub-division of Class Me as the star grows fainter.

There is some evidence of a relation between range of variation and period, and spectral class; larger ranges corresponding to longer periods and, at least for class Me, to later sub-divisions of the spectral class. A combination of large range and long period is accompanied almost invariably by a spectrum of a later subdivision of class Me.

There is no evident relation between maximum brightness and period or spectrum.

A forthcoming Harvard *Bulletin* will contain a more detailed discussion of this subject.

A DEVICE FOR COMPUTING THE COMPONENTS OF THE EARTH'S ORBITAL VELOCITY TO POINTS ON THE SUN.

By Ralph E. DeLury.

Since the angle between the ecliptic normal to the direction of the earth's orbital motion and any point on the sun's disc is always very small—at most 74′—it follows that the component of the orbital velocity of the earth to any point on the sun can be reduced to a linear measure-

ment of the distance along the ecliptic line lying between the projection of the point and the normal. The scale of velocity may be determined from the angle between the normal and the radius vector and the component along the radius vector, dR/dt; or better from the difference between the components along the radius vector and to an ecliptic limb point, this difference being, $r \cdot d\odot/dt$, where r is the solar radius. An apparatus has been constructed to facilitate the making of these measurements. A long line, graduated in millimeters, is scratched down the middle of a strip of celluloid. With its midpoint as centre, concentric circles, representing various diameters of the observed solar disc, are scratched on the celluloid, and concentric with these circles is mounted a ring graduated in degrees and within it a transparent disc. The pole of the ring, representing the pole of the sun, is set making the proper angle with the ecliptic pole for the time of the observation. The transparent disc with indicated points representing the positions of the various observed points on the solar disc, is moved to the proper position angle with respect to the pole of the ring (the sun), and the projections of these points on the millimeter scale of the ecliptic line are read off with reference to the reading for the normal. These readings along with the velocity scale readily give the components of velocity of the earth to the various observed points. Tables of the values of $r \cdot d\odot/dt$ and of the angle between the poles of the sun and the ecliptic are used in conjunction with the device.

PROPOSED FORM OF SPECTROHELIOGRAPH FOR SMALL AREAS.

By Ralph E. De Lury.

The successful results obtained by Dr. Hale with his spectrohelioscope led the writer to suggest the following forms suitable for photographing in any desired wave-length small solar images or small areas of larger images: (1) A rotating disc having numerous slits arranged in pairs on the same diameter, or diametral scratches on a silvered glass disc; (2) An oscillating plate of glass, or better a rotating glass bar of square, hexagonal, or octagonal cross-section placed in front of fixed inlet and exit slits of the spectrograph. The latter possesses the advantage that the slits are fixed. There is the disadvantage that the rate of separation of the area entering the slit varies rapidly after the glass surface has reached an inclination of 30°, so that a hexagon or octagon bar of glass would yield a more uniform exposure over the area. This difficulty could be met, however, by employing a graded filter in front of the glass bar. The slight focal differences of the image are not serious, but the focal curve of the exit image could be fitted by using film. By using motion-picture film and employing a tilting plate of glass to modify progressively the exit wave-length, interesting records of velocity could be made automatically over an area three-quarters of an inch

by an inch. It is to be noted that some such forms as these have also been mentioned by Dr. Hale.

GEOPHYSICAL METHOD FOR DETERMINING THE HOUR ANGLE OF A STAR FOR A GIVEN ALTITUDE.

By F. Henroteau and M. S. Burland.

The method depends on the use of two overlapping projections of the celestial sphere, on the planes of the meridian and the equator respectively. The declination and altitude circles being represented by straight lines, their intersection gives the required critierion, and a simple projection serves to locate the corresponding point on the hour circle. The paper will appear in the *Journal of the Royal Astronomical Society of Canada.*

A STUDY OF ETA AQUILAE.

By F. Henroteau and A. Vibert Douglas.

This paper constitutes a part of the continuous research on Cepheid variables made at the Dominion Observatory. It will be published in extenso in the *Publications* of that observatory.

It is divided in three parts (1) The Radial Velocities. (2) The Variation of Ionization, Band Intensity and Other Characteristics of the Spectra. (3) The Light-Curve.

The amplitude of the radial velocity of η Aquilae in 1927 was 36 km/sec, while in 1924 and 1925 it was about 44 km/sec. There is, no doubt, a change in the amplitude and also in the centre-of-mass velocity of the radial-velocity curve. This is in agreement with the results found by F. Henroteau for other Cepheids and for stars of the β Canis Majoris type.[1]

Microphotograms of most of the spectrograms of η Aquilae were obtained with a Moll instrument. From these it was found that very many lines change in intensity with the phase of the light variation. It is not exclusively the ionized and hydrogen lines which undergo these changes. Certain neutral lines, both ultimate and penultimate are similarly, but to a less degree, strengthened at maximum light. Examples of this are Ca 4227 and Fe 4260 and the ultimate vanadium line λ 4352.

Other neutral lines fall in intensity at maximum light and are strengthened noticeably at minimum. This is the case with Ti 4534.78.

A light-curve of η Aquilae was obtained with the photo-electric photometer.

[1] *Journal R. A. Soc. Canada*, **21**, 268, 1927.

PHOTOVISUAL MAGNITUDES AND COLOR INDICES OF BRIGHT STARS.

By Edward S. King.

1. Photovisual magnitudes for 123 stars, located both in the northern and in the southern hemispheres, have been determined from extra-focal images. These magnitudes agree with the photometric and the photographic scales for stars of Class A0.

2. The photovisual magnitude of Polaris is now found to be 2.01. The color index is +0.68.

3. Color indices based on photovisual rather than on visual observations show a more uniform, but steeper curve. This is due partly to the omission of a few dwarfs, but chiefly to the relation between the photovisual and the photometric scales. The curve from Class B2 to Class M, inclusive, may be represented by a straight line, having a slope of 0.437 magnitudes per spectral class.

PHOTOMETRY AT THE DETROIT OBSERVATORY.

By Dean B. McLaughlin.

In November, 1927, a program of visual photometry was inaugurated at Ann Arbor by Ausfeld with a Zöllner photometer attached to the 12-inch refractor. At the end of August, 1928, a total of about twelve thousand settings had been made on sixteen variables, of which eleven are known eclipsing binaries. The criteria for selection of most of the eclipsing stars were: (1) period greater than seven days, (2) spectral class later than F0. These two groupings overlap to a considerable extent. In only one case (Epsilon Aurigae) is a photometric orbit known to have been published. Other stars studied are RV Tauri and four late-type stars of questionable classification. Among these is W Serpentis, which is very probably an eclipsing star, rather than a Cepheid as formerly supposed.

Preliminary light curves have been obtained for eight of the eclipsing stars. The outstanding one is RZ Cancri, period 21.6 days, spectrum K0. The upper limit of mean density of this system is 0.003 ⊙, fulfilling the writer's prediction that it is a giant star. TT Herculis, for which Luizet found a period of 20.755 days, and which the writer believed to be a Cepheid with a period of 5.33 days has been found to be an eclipsing star with a period of 0.912 days. Two suspected variables have been found, viz.: BD —15°4832, used as comparison star for W Serpentis, and Leiner's comparison star"d" for BR Cygni (*A.N.*, **221**, 101).

BANDS BETWEEN Hγ AND Hδ IN THE SPECTRA OF EARLY TYPE STARS.

By Laura Hill McLaughlin.

More than two hundred microphotometric tracings of spectrograms, secured at Ann Arbor, of γ Lyrae and β Lyrae furnish material for an investigation of the bands in the spectra of stars to which Prof. Shapley has called attention. The tracings indicate that there are several bands, and that they show considerable variation. Fifty-three plates of γ Lyrae and sixty-seven of β Lyrae show three centers of concentration of the bands, at λ4310, λ4275, and λ4215. Estimates of intensity are valueless, due to differences in density of the individual spectrograms; actual measures are almost valueless, due to the extreme faintness of the bands. A comparison of tracings of γ Lyrae and β Lyrae from spectrograms made on the same night indicate in some instances the presence of the same bands and in other cases of different bands, suggesting a common and variable source of the bands, that is, our atmosphere. Lord Rayleigh found bands at λ4278 (negative band of nitrogen) and at λ4210 in the spectrum of the aurora and of the night sky. Spectrograms of β Lyrae and of P Cygni made during a night when there was a very strong aurora show very strong absorption. On the β Lyrae plate are the bands at λ4310 and λ4278 but the greatest absorption appears between λ4220 and Hδ. On the P Cygni plate the greatest absorption comes between Hγ and λ4175. Here again we have evidence pointing to a terrestrial source of the bands. Attempts to connect the bands with the rather complete meteorological data available at the Detroit Observatory proved futile; the bands have their source probably in a higher stratum of atmosphere than that which controls the weather and the changes in weather. An hour-angle test was made; it indicated that there was some other variable factor which at times counteracts the greater absorption due to increased length of path. From all the data considered, it would seem that the bands are of terrestrial origin and have their source in the upper atmosphere of the earth.

A STUDY OF THE FLASH SPECTRUM.

By Donald H. Menzel.

Various flash spectrum plates have been carefully examined and measured, with the view of obtaining as complete a catalogue as possible of wave-lengths, heights, intensities, etc., of the chromospheric lines. The present notes are of a preliminary character.

The spectral lines have been classified according to their appearance on the photographic plate. The classification adopted appears to have a definite physical meaning. The four main groups consist, respectively,

of lines of helium, ionized atoms of medium atomic weight, ionized atoms of high atomic weight (rare-earths), and ordinary neutral atoms. This classification, therefore, assists materially in identifying the atom to which a given line is due.

Many neutral lines, both ultimate and subordinate, particularly the former, show strongly in the prominences.

All of the intense lines are edged with emission wings. At the low density of the chromosphere this can hardly be attributed to anything else than the natural lack of sharpness in atomic tuning—wide lines being due, then, simply to a greater number of atoms in the line of sight. Classical theory and the new wave-mechanics provide for such an effect. Unfortunately, however, none of the flash plates was standardized photometrically. Nevertheless, preliminary measures show that the observed curves—blackening against distance from the center of the line—are all of the same shape, a result to be expected from wave-mechanics. True intensities have been obtained from relative widths of the emission lines, which agree quite well with Russell's theoretical intensities for components of multiplets. With this check, it is hoped that the procedure may be reversed and the line shapes themselves be used as photometric standards.

It seems quite probable that the natural overlapping of the wings of the crowded hydrogen lines near the head of the Balmer series is sufficient to give the illusion of continuous spectrum that appears somewhat to the red of the series limit. It is too early to say whether or not this explanation will account for the planetary nebulae as well.

The spectrum of γ Cygni, when compared with the flash shows a marked similarity—though not exact correspondence. The close agreement of many stellar and flash lines confirms the provisional identification at Mt. Wilson, Harvard, and elsewhere of the presence of rare earths in stellar spectra.

The arbitrary scale of emission intensities was made to correspond as closely as possible with that of Rowland for absorption. The scale was then calibrated by means of Russell's theoretical intensities of multiplet components. The curve obtained agrees quite well with that obtained similarly at Mt. Wilson for the Fraunhofer spectrum and provides an absolute intensity scale for estimating relative numbers of atoms acting to produce given flash lines.

STRUCTURE OF THE SOLAR CHROMOSPHERE.

By Donald H. Menzel.

During the past few years various investigators, notably Milne, have developed a highly specialized theory of the chromosphere for an atmosphere of ionized calcium in equilibrium under the forces of gravity and radiation pressure. Theory has so far distanced observation that it seems especially desirable to check it where possible.

It may be safely assumed (as far as order of magnitude is concerned) that the density of the chromosphere at the point where a given spectral line vanishes, (the point usually called the "height" to which a line is visible), is inversely proportional to the true intensity of the line. This latter may be obtained from the multiplet calibration mentioned in the preceding abstract.

The density law thus found from the observations is much more rapid for the lower levels than the theoretical prediction for a chromosphere totally supported by radiation pressure, yet much less rapid than if no forces opposed to gravity were acting. It is possible to estimate tentatively that this force opposed to gravity supports approximately 80% of the weight of the atom at the 500 km level, a figure that steadily increases with height until, at the 2500 km level, about 99% of the weight is supported. Above 4000 km, the density appears to diminish less rapidly, agreeing fairly well with Milne's theory for a limiting coefficient of partial support of about 10^{-3}. If Milne's theory of the chromosphere be correct, the above observations must be taken to mean that monochromatic radiative equilibrium does not exist below 4000 km.

There is evidence, however, that electrostatic fields, neglected by Milne, are possibly more important than radiation pressure in supporting certain atoms. Stewart has shown theoretically that ionized atoms of low atomic weight may actually be lifted without any assistance from radiation pressure. Something of this sort is apparently necessary to explain the presence of hydrogen and helium, for the continuous spectrum beyond the limit of the Balmer series indicates that a large part, if not all, of the intensity of the Balmer lines is due to electron capture—a process which can contribute but little to chromospheric support. The electrostatic levitation for ionized atoms of high atomic weight would be much less, accounting for the observed condensation of the rare earths. (See preceding abstract.)

Further study of the chromosphere, including the promising field of widths and shapes of the emission lines, is under way, but it is too early to foretell whether or not the various independent lines of attack will agree.

SPROUL AND McCORMICK MEASURES OF BD +33°256-7.

By S. A. Mitchell.

In *Publications A.S.P.*, **40**, 191, Pitman raises the question whether BD +33°256-7 may not be a multiple system. The star BD +33°257 was discovered by Aitken to be a close double and is designated A1913. The relative parallax of this double measured on the McCormick plates by Olivier is $+''.013 \pm ''.008$, while the value found by Miss Onderdonk from the Sproul plates is $+''.036 \pm ''.014$. Pitman, considering these results discordant, remeasured the series of Sproul plates, using another set of comparison stars, and derived the relative parallax

+".051 ± ".008. The disagreement with the McCormick parallax is still greater than was shown by the first Sproul determination.

It is difficult to see the reasons why Pitman considered the parallaxes of Olivier and Miss Onderdonk discordant. If we take the straight mean of the two determinations, we derive the relative parallax +".024 with the average probable error ±".011. In other words, each determination differs from the mean by the probable error. The mean of the two Sproul results is +".044. This combined with the McCormick relative parallax gives the direct mean of +".028 from which comes an absolute parallax of +".032.

On the Sproul plates Pitman measured BD +33°256, a star about equal in brightness with A1913 and at a distance of seventy seconds of arc. It was also measured by Olivier in 1924, but the McCormick parallax has not yet been published. The Pitman and Olivier measures of both stars are given below, together with the proper motions in right ascension from the parallax plates and from the meridian circle results published in the *Geschichte des Fixsternhimmels*.

Star	Obs.	Rel. Par.	Proper Motion	
			Photographs	Mer. Circle
BD +33°257	P	+".051	—".010	—".113
	O	+.013	—.081	
BD +33°256	P	+.053	—.003	—.032
	O	+.024	+.002	

Although the meridian circle results listed above depend on only two observations of each of these stars, Pitman and Olivier are both in substantial agreement with the meridian circle proper motions for BD +33°256. Olivier's measures of BD +33°257 again show an agreement in proper motion with the meridian-circle value, but Pitman's measures show a large discordance.

In view of the above results it seems certain that the stars BD +33°256-7 do not form a multiple system.

TWO RECENT SOLAR ERUPTIONS.

By W. W. Morgan.

Two eruptions occurred on the sun on July 17, 1928, which were unusual for their brilliancy and shortness of duration. The disturbances broke out in the vicinity of a group of small spots near the center of the solar disk. The first was in the shape of a rough spiral about 25,000 miles in diameter, and very narrow except for a condensation at one end. The most brilliant phase lasted only a few minutes, but scattered remnants were visible for about an hour. At its height, it was the most brilliant disturbance ever photographed on the sun at the Yerkes Observatory. The second eruption broke out near the fading fragments of the first and attained its greatest brilliancy only three minutes after its

first appearance. Its total life was only about ten minutes. At its maximum, it was about 16,000 miles long and was shaped like a small Greek zeta. The outbursts were photographed with the spectroheliograph attached to the 40-inch telescope, through the [H] line of calcium.

RESULTS OF REFLECTED OBSERVATIONS.

By H. R. Morgan and G. M. Raynsford.

On 74 nights in the years 1914-1917 some 2300 direct and reflected observations of stars were taken on the 9-inch transit circle at the U. S. Naval Observatory. The observations extended from 16 to 69 degrees each side of the zenith. They have been reduced with the use of the flexures given by measures on the horizontal and vertical collimators.

The residuals show practically no discordance between the direct and reflected observations, and justify the use of the collimator flexures on this instrument.

(To be continued.)

PLANET NOTES FOR JANUARY.

By CLIFFORD E. SMITH.

The *Sun* will be moving northeast from the central part of Sagittarius to the central part of Capricornus. On January 1 the earth will be at perihelion; that is, the earth will be nearest the sun on that date. The position of the sun on January 1 and January 31 will be respectively, R.A. $18^h\ 44^m$, Decl. $-23°\ 4'$; and R.A. $20^h\ 52^m$, Dec. $-17°\ 35'$.

The phases of the *Moon* will occur as follows:

Last Quarter	Jan. 2 at 1 P.M.	C.S.T.
New Moon	10 " 6 P.M.	"
First Quarter	18 " 9 A.M.	"
Full Moon	25 " 1 A.M.	"

The moon will be at apogee January 7, and at perigee January 23.

Mercury will be moving from the central part of Sagittarius to the eastern edge of Capricornus. On January 12, Mercury will be in conjunction with the moon, and at this time it will be about three degrees away. During the middle of the month Mercury will set about one hour after the sun. Its apparent motion during the month will be direct. On January 22 it will be at greatest elongation east.

Venus will be moving from the western edge of Aquarius to the western edge of Pisces. On January 14 Venus will be in conjunction with the moon. At that time it will be about four degrees from the moon and it will set about three hours after the sun. Its apparent motion among the stars will be direct.

Mars will be in the eastern part of Taurus. Until the twenty-seventh of the month its apparent motion among the stars will be retrograde. On January 22 Mars will be in conjunction with the moon, and at that time it will be distant about twice the diameter of the moon. During the middle of the month it will be on the meridian about 10:00 P.M.

Jupiter will be in the eastern part of Pisces. On January 22 it will be in

THE CONSTELLATIONS AT 9:00 P.M. JANUARY 1.

quadrature east of the sun, and at that time it will be on the meridian at 6:00 P.M. On January 18 it will be in conjunction with the moon, and it will be distant about twice the diameter of the moon. The apparent motion of Jupiter among the stars will be direct.

Saturn will be near the western border of Sagittarius. During the middle of the month it will rise about two hours before the sun.

Uranus will be in the central part of Pisces, and will set about 10:30 P.M. during the middle of the month. Its apparent motion will be direct.

Neptune will be in Leo near Regulus. During the middle of the month it will be on the meridian about 2:30 A.M. Its apparent motion will be retrograde.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1929	Star's Name	Magnitude	IMMERSION. Washington C.T.	IMMERSION. Angle from N	EMERSION. Washington C.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
Jan. 1	ν Virginis	4.2	0 15	109	1 22	308	1 7
6	41 Librae	5.3	3 29	58	4 01	359	0 32
	κ Librae	5.0	5 26	49	5 50	13	0 24
16	14 Ceti	5.4	22 01	6	22 35	297	0 34
19	145 B. Arietis	6.5	18 42	84	19 54	214	1 12
21	51 Tauri	5.6	2 43	84	3 34	260	0 51
	56 Tauri	5.2	3 16	50	3 58	295	0 42
	103 Tauri	5.5	20 18	82	21 37	247	1 19
27	46 Leonis	5.8	0 25	152	1 32	268	1 07
30	48 Virginis	6.5	2 48	132	4 10	306	1 22

Monthly Report of the American Association of Variable Star Observers, for the Month of October, 1928.

The Seventeenth Annual meeting of the Association came off as per schedule on October 20 at Cambridge. Members were present from many states, and it was a steady round of activities from the start on Friday evening, when Professor E. W. Brown of Yale held forth at a Harvard Open Night talking on the "Rotation of the Earth," until late Saturday night when Dean Potter offered the usual resolutions of thanks and appreciation to Dr. and Mrs. Shapley, and the Observatory staff, for their efforts in behalf of the Association. It surely was a real meeting in every sense of the word, not only from a social get-together standpoint, but also when viewed from the scientific aspect. Numerous papers were read, and the discussion which followed was even more lively and interesting than the actual reading.

Unfortunately, President Pickering was prevented by illness from being present and his absence was keenly felt, but Vice President Alice Farnsworth ably attended to those duties.

Messrs. Felix de Roy, of Antwerp, Belgium, and A. N. Brown, of Brackenhurst, England, Director and Secretary, respectively, of the Variable Star Section of the B.A.A., were unanimously elected to Honorary Membership in the Association. Besides these, Secretary Olcott reported the election of more than a dozen new members since the last meeting.

On the day of the meeting a goodly number of observations were received from Clinton Ford, made during his short sojourn at Leiden, Holland, through the kindness of Professor de Sitter, Director of the Observatory at that place.

The Foreign Meetings Symposium, held following the dinner, was a complete

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1928.

August 0 = J.D. 2425459; September 0 = J.D. 2425490; October 0 = J.D. 2425520.

J.D.Est.Obs.

V SCL
000339
470 12.7 Bl
481 12.2 Bl

S SCL
001032
470 9.0 Bl
475 7.8 Ht
477 8.6 En
481 8.9 Bl
482 8.8 Ht
493 8.1 Dr
499 7.7 Kd
505 7.8 Kd
513 7.6 Kd

X AND
001046
493 12 0 Lj
495 11.9 Lj
497 11.8 Lj
502 11.8 Lj
505 11.8 Lj
506 11.5 Ch
510 12.2 Lj
514 12.5 Lj

T CET
001620
496 5.8 L
500 5.7 An
503 5.9 L
510 6.3 An
512 6.1 L

T AND
001726
482 11.1 Ch
496 9.9 Ch
507 9.0 Pt
510 8.9 Sc
527 8.4 Jo
528 8.3 Sc
530 8.1 Jo

T CAS
001755
482 7.7 Ch
491 7.6 L
493 7.5 Ch
502 7.7 L
505 7.8 Ch
506 7.9 Jo
507 8.3 Pt
510 7.8 L
511 7.9 Jo
518 8.0 L
526 8.5 Jo
530 8.7 Jo

R AND
001838
482 8.1 Ch
492 7.2 Ah

R AND
001838
493 7.2 Ah
495 7.1 Ah
496 7.0 Ch
497 7.2 Ah
502 6.8 Ah
503 6.7 Ah
506 5.7 Ah
506 6.8 Gy
507 6.5 Pt
508 6.6 Ah
510 6.6 Sc
511 6.7 Sb
511 7.3 Wd
511 6.9 Jo
512 6.6 Ah
514 6.4 Ah
516 6.5 Ah
517 6.6 Ah
518 6.5 Sc
521 6.7 Wd
525 6.6 Sb
526 6.9 Sc
526 6.8 Jo
527 6.5 Gv
528 6.8 Wd
530 6.6 Jo

S TUC
001862
465 12.4 En
470[14.0 Bl
475[13.2 En

S CET
001909
498 14.6 L
500[13.3 An
505 14.5 L

T SCL
002438a
493 13.5 Dr

RR SCL
002438b
493 12.8 Dr

T PHE
002546
468[13.0 Sm
470[14.1 Bl
477[12.2 En
493 13.5 Dr

W SCL
002833
470 13.0 Bl
493 13.2 Dr

Y CEP
003179
510 10.1 Sf
521 10.2 Sf
529 9.7 Hu

Y CEP
003179
531 10.4 Sf

U CAS
004047
507 8.2 Pt
516 8.1 Sc
523 8.3 Sb
523 8.3 Cl
537 8.4 Sb

RW AND
004132
482 10.8 Ch
507 11.0 Pt

V AND
004435
470 11.0 Bl

RV CAS
004746a
507 13.5 Pt

— CAS
004746b
507 10.6 Pt

W CAS
004958
507 8.6 Pt
511 8.2 Jo
526 8.6 Jo
530 8.4 Jo

U TUC
005475
462 11.8 Bl
465 12.0 En
468 12.5 Sm
470 12.1 Bl
475 12.9 En

Z CET
010102
524 11.9 Pt

U SCL
010630
470 10.3 Bl
505 13.4 Dr

RU CEP
010884
506 13.3 Ch
524 13.2 Pt

W AND
021143a
506[12.9 Ch
524 13.0 Pt

T PER
021258
482 9.0 Ch
524 8.1 Pt

o CET
021403
475 2.7 Wf
477 2.7 Wf
477 2.7 En
479 2.7 Wf
481 2.6 Ch

RU CEP
010884
509 8.9 L
510 8.9 L
512 9.0 L
513 8.9 L
514 8.8 L
515 8.8 L
517 8.9 L
518 8.9 L
519 8.9 L
520 8.9 L

U AND
010940
509[13.3 Lg

U PSC
011712
524 11.6 Pt
531 12.0 Sf

R PSC
012502
482[11.8 Ch
530 11.1 Al

RU AND
013238
482 11.2 Ch
506 12.2 Ch
507 12.2 Pt
509 12.3 Lg

Y AND
013338
506 13.3 Ch
507 13.8 Pt

X CAS
014958
507 11.2 Pt

U PER
015254
507 10.0 Pt
529 10.0 Hu

R ARI
021024
506 13.3 Ch
524 13.2 Pt

S PER
021558
482 9.4 Ch
491 8.8 L
492 8.7 L
496 8.9 L
497 8.9 L
498 8.9 L
499 8.9 L
500 9.0 L
501 9.0 L
502 8.9 L
503 8.9 L
504 8.9 L
505 8.9 L
507 9.0 L
508 9.0 L

o CET
021403
485 2.7 Ch
492 3.0 L
492 3.0 Ah
494 3.1 Ah
494 3.0 An
495 3.2 Ah
496 3.0 L
497 2.9 Wf
497 3.2 Ah
498 3.3 Ah
499 3.4 Ah
500 2.9 Wf
501 2.8 Ch
502 3.3 Ah
502 2.9 Gy
503 3.4 Ah
503 3.1 Wf
504 3.1 L
505 3.4 Ah
506 2.9 Gy
507 2.9 Lg
509 3.2 Lg
509 3.1 L
509 3.5 An
511 3.4 Sp
511 3.6 Jo
512 3.8 Ah
513 3.1 Lg
514 3.6 Sc
516 3.2 L
517 3.7 Ah
524 3.7 Pt
526 4.1 Jo
526 3.8 Sc
526 3.9 Sp
527 3.1 Lg
527 3.9 Gy
528 3.6 Wd
529 4.0 Hu
530 4.0 Sp

S PER
021558
478[12.2 En
505 13.4 Dr

T HOR
025751
470 9.1 Bl
505 11.0 Dr

X CET
031401
491 11.9 L
502 11.9 L
510 11.7 L
518 11.5 L
524 11.1 Pt

Y PER
032043
524 9.0 Pt

U CET
022813
482 8.0 Ch
506 8.0 Gy
524 7.8 Pt
526 8.1 Sb
527 8.4 Gy

RR CEP
022980
497 14.5 L
504 14.2 L
510 13.3 L
518 13.3 L
531 12 9 Sf

R TRI
023133
492 7.2 Ah
493 7.2 Ah
495 7.4 Ah
496 7.4 Ch
498 7.4 Ah
502 7.6 Ah
503 7.7 Ah
506 8.0 Ah
510 9.0 Sf
511 8.4 Wd
511 8.1 Jo
512 8.3 Ah
517 8.6 Ah
521 9.2 Sf
524 8.8 Pt

W PER
024356
520 [9.9 Sc
523 10.7 Cl
524 10.2 Pt
530[10.2 Sc

R HOR
025050
470 12.7 Bl
478[12.2 En
505 13.4 Dr

T HOR
025751
470 9.1 Bl
505 11.0 Dr

X CET
031401
491 11.9 L
502 11.9 L
510 11.7 L
518 11.5 L
524 11.1 Pt

Y PER
032043
524 9.0 Pt

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R PER	R RET	T COL	AN ORI	R COL	AG AUR
032335	*043263*	*051533*	*053005t*	*054629*	062047
509 13.0 Lg	495 10.5 Dr	498 8.4 Dr	492 10.9 L	504[13.0 Dr	492 9.2 L
T FOR	X CAM	S AUR	496 10.7 L	α ORI	497 9.0 L
032528	043274	052034	497 10.8 L	054907	499 9.2 L
498 8.7 L	402 8.2 Br	510 10.2 Pt	498 10.9 L	515 0.9 L	507 9.5 L
505 8.7 L	409 8.6 Br	527 11.5 Sp	499 10.8 L	517 0.8 L	515 9.5 L
512 8.8 L	413 8.8 Br	W AUR	500 10.9 L	519 0.9 L	R MON
U ERI	415 9.1 Br	052036	501 11.0 L	520 0.9 L	063308
034625	469 12.9 Br	497 14.1 L	502 10.9 L	U ORI	510 10.8 Pt
505 12.1 Dr	478 12.5 Br	514 14.5 L	503 10.9 L	054920a	S LYN
T ERI	483 11.6 Br	RR CAM	504 10.8 L	502 8.1 Ah	063558
035124	484 11.5 Br	052372	505 10.8 L	504 6.3 Kz	510 13.9 Pt
505 10 9 Dr	486 11.5 Br	402 10.1 Br	507 10.9 L	505 7.1 Ch	X GEM
W ERI	510 9.4 Pt	409 10.1 Br	509 10.9 L	510 6.5 Pt	064030
040725	R DOR	413 10.1 Br	510 10.9 L	512 6.8 Ah	527 9.6 Sp
505 12.6 Dr	*043562*	415 10.3 Br	512 11.0 L	516 6.7 Ah	W MON
RY CAM	470 5.5 Bl	469 10.7 Br	514 11.0 L	517 6.5 Ah	*064707*
042164	498 5.5 Dr	478 10.9 Br	515 10.9 L	520 6.3 Ah	510 9.4 Pt
402 8.0 Br	505 5.0 Dr	483 11.0 Br	517 10 9 L	526 6.1 Jo	X MON
409 8.1 Br	R CAE	484 11.0 Br	519 10.9 L	WW ORI	*065208*
413 8.2 Br	*043738*	486 11.1 Br	520 11.0 L	054920b	497 7.4 L
415 8.3 Br	470 9.3 Bl	491 11.1 Br	S CAM	504 11.1 Kz	505 7.5 L
469 8.4 Br	498 9.6 Dr	S ORI	053068	Z AUR	512 7.6 L
478 8.6 Br	R PIC	*052404*	510 10.0 Pt	055353	R LYN
483 8.5 Br	*044349*	510 11.8 Pt	511 10.5 Pc	402 11.0 Br	065355
484 8.6 Br	470 7.1 Bl	T ORI	RU AUR	409 11.1 Br	492 8.3 Ah
486 8.5 Br	498 7.7 Dr	*053005a*	053337	415 11.0 Br	493 8.1 Ah
R TAU	R LEP	491 10.1 L	510[12.5 Pt	469 10.0 Br	495 8.3 Ah
042209	*045514*	492 10.2 L	SU TAU	478 10.0 Br	497 8.4 Ah
510 9.5 Pt	491 6.1 L	494 11.3 An	054319	484 10.2 Br	498 8.5 Ah
527 9.0 Sp	496 6.1 L	496 10.4 L	481 9.8 Ch	486 10.2 Br	502 8.5 Ah
W TAU	503 6.0 L	497 10.2 L	491 9.4 L	505 10.6 Ch	506 8.7 Ah
042215	505 7.0 Ch	498 10.3 L	492 9.5 L	505 10.2 Pt	512 8.8 Ah
510 11.0 Pt	510 6.3 Pt	499 10.2 L	496 9.5 L	506 10.2 Pt	514 8.8 Ah
T CAM	512 6.2 L	500 10.2 L	497 9.5 L	510 10.5 Pt	V CMI
043065	V ORI	501 10.4 L	498 9.5 L	511 10.2 Pt	070109
402 9.0 Br	050003	502 10 2 L	499 9.5 L	514 10.4 Pt	505 8.9 Ch
409 9.0 Br	505 9.3 Ch	503 10.1 L	500 9.6 L	524 10.6 Pt	512 8.6 Sf
413 9.0 Br	510 9.9 Pt	504 10.2 L	502 9.5 L	525 10.6 Pt	R GEM
415 9.1 Br	T LEP	505 10.1 L	503 9.5 L	529 10.6 Pt	070122a
469 8.3 Br	*050022*	507 10.1 L	504 9.4 L	530 10.6 Pt	510 12.9 Pt
478 8.6 Br	510 11.6 Pt	508 10.2 L	506 9.6 Pt	531 10.4 Pt	Z GEM
483 8.6 Br	S PIC	509 10.0 L	507 9.6 Lg	R OCT	070122b
484 8.6 Br	*050848*	510 10.2 L	507 9.5 L	*055686*	510 12.4 Pt
486 8.6 Br	470 8.0 Bl	510 10.0 Pt	508 9.5 L	461 9.9 Bl	TW GEM
496 8.6 L	R AUR	511 10.2 Pt	509 9.5 L	465 10.3 En	070122c
504 8.7 L	050953	512 10.2 L	510 9.5 L	468 10.9 Sm	510 8.0 Pt
509 9.2 Lg	510 12.9 Pt	514 10.3 L	510 9.6 Pt	468 10.4 Bl	R CMI
510 9.1 Pt	T PIC	514 9.9 Pt	511 9.6 Pt	475 10.5 En	070310
512 8.8 L	*051247*	516 10.3 L	512 9.7 Sf	498 11.2 Dr	497 8.0 L
512 8.9 Sc	470 9.4 Bl	517 10.2 L	514 9.6 Pt	504 11.0 Dr	505 7.6 L
RX TAU	498 11.8 Dr	518 10.1 L	514 9.5 L	X AUR	505 8.2 Ch
043208	NOV TAU	519 10.2 L	515 9.6 L	060450	514 8.0 L
510 12.6 Pt	051316	520 10.1 L	517 9.6 L	510 9.8 Pt	R VOL
512 11.8 Sf	498 13.4 L	527 10.4 Sp	518 9.5 L	527 11.5 Sc	*070772*
528 10.8 Sf	507 13.3 L	531 9.8 Pt	519 9.5 L	V MON	504 9.8 Dr
R RET	517 13.5 L	AN ORI	525 9.6 Pt	*061702*	L_2 PUP
043263		*053005t*	527 9.8 Sp	505 9.0 Ch	*071044*
470 11.9 Bl		491 10.7 L	531 9.6 Pt	510 8.5 Pt	504 4.6 Dr

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V GEM	R CHA	R LMI	U HYA	RS UMA	T UMI
071713	*082476*	093934	*103212*	123459	133273
510 13.2 Pt	466[12.6 Bl	508 11.1 Ch	395 5.3 Kn	523 8.7 Fd	511 10.7 Pc
S CMI	467[12.4 Sm	511 10.5 Pt	RZ CAR	524 8.5 Fd	T CEN
072708	X UMA	R LEO	*103270*	526 8.7 Sc	*133633*
511 8.5 Pt	083350	094211	498[13.6 Dr	530 8.8 Sc	461 7.9 Bl
S VOL	511 10.3 Pt	508 6.1 Ch	R UMA	S UMA	463 8.4 En
073173	S HYA	511 5.8 Pt	103769	123901	466 8.6 Ht
466[13.2 Bl	084803	X LEO	511 12.7 Pt	493 10.6 Lj	468 8.2 Sm
467[11.4 Sm	505 7.8 Ch	094512	V HYA	494 10.5 An	468 7.9 Bl
504[13.2 Dr	511 7.5 Pt	514[12.5 L	*104620*	494 10.9 Ah	473 8.2 En
U CMI	T HYA	515[14.0 L	461 8.5 Bl	495 11.0 Ah	475 7.9 Ht
073508	*085008*	517[14.0 L	468 8.5 Bl	497 10.8 Lj	479 7.0 En
497 8.9 L	505 8.3 L	518[12.3 L	480 8.5 Bl	498 10.9 Lj	480 7.0 Bl
505 8.6 L	514 7.5 L	519[12.0 L	RS HYA	499 11.0 Kl	482 7.0 Ht
511 8.7 Pt	T CNC	520[12.3 L	*104628*	501 11.0 Kl	483 6.8 En
514 8.9 L	085120	Z VEL	468 12.6 Bl	502 11.2 Lj	486 6.9 Ht
S GEM	508 9.0 Ch	*094953*	RS CAR	503 11.2 Ah	498 6.2 Dr
073723	511 8.0 Pt	461 8.9 Bl	*110361*	503 11.0 Kl	504 5.9 Dr
481[10.1 Ch	V UMA	463 9.3 En	463[12.3 En	503 11.3 Pc	RT CEN
T GEM	090151	467 9.2 Sm	467[12.3 Sm	505 11.3 Lj	*134236*
074323	496 10.4 L	468 9.0 Bl	RY CAR	506 11.4 Ah	461 9.2 Bl
481 10.4 Ch	505 10.2 L	472 9.4 En	*111561*	511 11.4 Be	464 9.2 En
511 10.6 Pt	514 9.9 L	480 9.6 Bl	468[13.1 Bl	511 11.4 An	466 9.6 Ht
R CNC	W CNC	V LEO	498[13.2 Dr	511 11.6 Pt	468 9.4 Sm
081112	090425	095421	RS CEN	514 11.7 Lj	468 9.2 Bl
511 10.1 Pt	504 11.9 L	511 10.8 Pt	*111661*	U OCT	473 9.4 En
Z CAM	514 12.2 L	RV CAR	463 11.6 En	*131283*	475 9.5 Ht
081473	RX UMA	*095814*	467 11.6 Sm	461 12 0 Bl	480 9.5 Bl
491 11.7 L	090567	463[11.6 En	468 11.3 Bl	465 12.4 En	482 9.7 Ht
492 12.0 L	496 11.3 L	466[13.1 Bl	473 10.8 En	466 11.9 Ht	498 9.6 Dr
494 12.5 L	498 11.2 L	472[11.6 En	480 10.7 Bl	467 11.6 Sm	505 9.6 Dr
496 13.0 L	500 11.2 L	S CAR	498 9.2 Dr	468 11.9 Bl	R CVN
497 13.3 L	502 11.2 L	*100661*	X CEN	475 11.4 En	134440
498 13.3 L	503 11.2 L	461 6 6 Bl	*114441*	475 11.8 Ht	512 9.6 Kz
499 13.1 L	507 11.4 L	463 6.9 En	468 13.2 Bl	480 11.8 Bl	512 9.7 Eb
500 13.1 L	509 11.0 L	466 6.7 Ht	W CEN	482 11.5 Ht	512 9.8 Ed
501 13.1 L	512 11.3 L	467 6.5 Sm	*115058*	498 9.5 Dr	RX CEN
502 13.0 L	517 11.2 L	468 6.2 Bl	461 8.4 Bl	505 8.9 Dr	*134536*
503 13.0 L	520 11.4 L	472 6.4 En	463 8.1 En	R HYA	468 13.8 Bl
504 13.1 L	RW CAR	475 6.4 Ht	466 8.3 Ht	*132422*	T APS
505 13.0 L	*091868*	480 6.0 Bl	467 8.3 Sm	461 0.6 Bl	*134677*
507 11.3 L	466 12.5 Bl	498 5.4 Dr	468 8.7 Bl	464 6.4 En	461 10.1 Bl
508 10.6 L	480 12.0 Bl	504 5.4 Dr	473 8.6 En	467 6.1 Sm	465 10.2 En
509 10.6 L	Y VEL	505 5.5 Dr	475 8.6 Ht	468 5.9 Bl	467 10.4 Sm
510 10.7 L	*092551*	Z CAR	480 9.0 Bl	469 7.4 Kd	468 10.9 Bl
512 10.3 L	466[12.4 Bl	*101058*	482 8.8 Ht	473 6.4 En	475 11.2 En
513 10.5 L	467[12.1 Sm	464[11.8 En	U CEN	480 5.8 Bl	480 11.4 Bl
514 10.4 L	R CAR	466[12.3 Bl	*122854*	S VIR	498 12.1 Dr
515 10.6 L	*092062*	469[12.3 Sm	461 9.3 Bl	*132706*	505 12.4 Dr
516 11.4 L	461 8.6 Bl	473[12.3 En	468 10.0 Bl	467 8.4 Sm	Z BOO
517 11.4 L	463 8.8 En	505[11.8 Dr	480 11.2 Bl	RV CEN	140113
518 11.4 L	466 9.1 Ht	W VEL	T UMA	*133155*	402 11.6 Br
519 11.8 L	467 9.2 Sm	*101153*	123160	461 7.9 Bl	405 11.4 Br
520 12.2 L	468 9.0 Bl	467[12.0 Sm	511 12.6 Pt	468 8.3 Bl	409 11.6 Br
V CNC	472 9.0 En	468[13.0 Bl	RS UMA	480 8.0 Bl	413 11.8 Br
081617	480 9.0 Bl	U HYA	123459	498 8.7 Dr	RU HYA
508 8.5 Ch	498 9.8 Dr	*103212*	511 9.9 Pt	505 8.8 Dr	*140528*
511 8.0 Pt	504 9.2 Dr	373 5.3 Kn	512 9.0 Sc		464[12.5 En
		386 5.7 Kn	520 9.0 Sc		468 14.0 Bl

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
RU Hya			V Boo			S Aps			R Nor			R CrB			R CrB		
140528			142539a			*145971*			*152849*			154428			154428		
473	[12.5	En	481	7.6	Ch	480	[13.4	Bl	463	9.4	En	468	5.7	Kn	508	6.1	Ah
480	[12.9	Bl	495	7.9	Kd	482	[11.9	Ht	468	9.4	Sm	469	6.0	Kd	509	6.0	Be
505	12.9	Dr	495	7.1	Be	Y Lib			468	9.0	Bl	470	6.0	Kn	509	6.1	L
R Cen			495	7.2	An	*150605*			473	9.4	En	472	5.9	Kd	509	6.0	Gb
140959			497	7.9	Kd	495	11.5	L	480	9.7	Bl	475	5.9	Kd	509	5.9	Kd
461	8.1	Bl	498	7.9	Kd	503	9.6	L	498	10.4	Dr	480	5.9	Kd	510	6.0	L
463	8.3	En	501	7.8	Kd	503	9.7	Pt	505	10.4	Dr	481	6.1	Ch	510	6.2	Lj
466	9.1	Ht	503	7.2	Pt	515	8.9	L	X Lib			485	6.1	Kn	510	6.2	Pt
468	8.3	Sm	505	7.7	Kd	S Lib			*153020*			487	5.9	Kd	511	6.1	Pt
468	8.1	Bl	510	7.9	Sc	*151520*			461	10.8	Bl	487	5.9	Kn	511	6.2	Sb
475	9.0	En	511	7.8	Be	498	8.2	L	468	10.1	Bl	491	6.1	L	511	6.0	Pc
475	9.1	Ht	511	7.7	An	503	8.4	Ch	480	10.0	Bl	491	5.9	Kd	511	6.0	An
480	8.8	Bl	512	8.5	Kz	504	8.3	L	W Lib			491	6.2	Lj	511	6.2	Wd
482	9.4	Ht	512	8.1	Eb	S Ser			*153215*			492	6.1	L	512	6.0	Kz
482	9.0	En	520	8.0	Sc	151714			469	[12.5	Bl	492	6.1	Ah	512	6.3	Eb
498	9.2	Dr	521	7.8	Fd	495	7.8	Be	S UMi			493	6.1	Ch	512	6.5	Ed
505	9.1	Dr	523	7.8	Fd	495	8.1	An	153378			493	6.2	Lj	512	6.1	Sp
U UMi			524	8.0	Fd	495	8.1	L	482	9.3	Ch	494	6.1	Ah	512	6.1	Sc
141567			R Cam			502	8.1	L	491	9.8	Lj	494	6.2	Lj	514	6.0	An
491	7.8	Lj	142584			502	8.0	Lg	493	9.8	Lj	495	6.2	Lj	514	6.2	Lj
492	7.6	Ah	500	[10.9	Ch	503	8.0	Pt	497	9.8	Lj	495	5.9	Kd	515	6.2	Lj
493	7.7	Ah	R Boo			504	8.3	Kz	502	9.7	Lj	495	6.1	Ah	515	6.2	Pt
493	7.8	Lj	143227			511	8.1	An	502	8.7	Lg	495	6.0	L	516	6.2	Lj
494	7.8	Ah	493	7.9	Lj	512	8.1	Sb	503	8.0	Pt	495	6.2	An	517	6.2	Lj
495	7.7	Ah	495	7.9	Lj	513	8.1	Lg	505	9.8	Lj	497	6.1	An	517	6.1	Pt
497	7.8	Ah	498	7.9	Lj	517	8.0	L	506	8.8	Gy	497	6.1	L	517	6.1	Be
497	7.9	Lj	500	7.4	Ch	526	8.3	Sb	510	9.5	Lj	497	6.2	Lj	517	6.0	Ah
500	7.6	Ch	502	7.9	Lj	527	8.5	Lg	511	8.4	Jo	498	6.2	Lj	518	6.0	L
502	8.2	Lj	502	7.4	Hs	S CrB			512	8.7	Sc	498	6.0	Kd	518	6.2	Lj
502	8.1	Ah	503	6.5	Pt	151731			512	9.1	Lj	499	6.0	L	518	6.2	Pt
503	7.9	Ah	505	7.7	Lj	500	11.0	Ch	513	8.8	Lg	499	6.4	Kl	519	6.0	L
503	8.0	Pc	511	6.9	Hs	503	10.8	Pt	514	9.2	Lj	500	6.0	L	521	6.0	Fd
503	7.6	Pt	512	7.0	Hs	503	10.8	Pc	518	8.8	Lj	500	6.0	Kd	521	6.2	Wd
506	8.3	Ah	512	6.8	Kz	523	8.8	Fd	527	8.5	Gy	500	6.0	L	522	6.3	Kl
508	8.4	Ah	512	7.0	Eb	523	8.8	B	530	8.4	Jo	501	6.3	Kl	523	5.9	Fd
510	7.9	Lj	512	6.7	Ed	524	8.6	Fd	U Lib			501	6.0	L	523	6.1	Pt
512	8.5	Ah	514	6.8	Lj	RS Lib			*153620a*			501	6.1	Kd	524	6.2	Pt
514	8.1	Lj	516	6.7	Lj	*151822*			469	12.4	Bl	502	6.0	L	524	5.9	Fd
516	8.5	Ah	520	7.2	Sc	461	10.4	Bl	480	12.6	Bl	502	6.1	Kd	525	6.0	Kl
517	8.4	Ah	Y Lup			464	11.0	En	T Nor			502	6.2	Lj	525	6.2	Sb
520	8.5	Ah	*145254*			466	11.5	Ht	*153654*			503	6.2	Lj	525	6.1	Pc
523	8.5	Cl	461	12.5	Bl	468	11.1	Sm	464	7.5	En	503	6.3	Kl	527	6.1	Pt
S Boo			464	12.4	En	468	11.0	Bl	466	8.1	Ht	503	6.2	Pc	527	6.2	Gy
141954			468	12.4	Sm	473	11.0	En	468	7.6	Sm	503	6.0	L	528	6.0	Wd
481	8.3	Ch	468	11.6	Bl	475	11.5	Ht	473	8.6	En	503	6.1	Ch	528	6.1	Pt
495	9.1	L	473	11.3	En	480	10.5	Bl	475	8.5	Ht	503	6.2	Pt	529	6.2	Pt
495	9.1	Be	480	11.1	Bl	498	11.3	L	482	9.5	Ht	503	6.2	Ah	530	6.2	Pt
495	9.0	An	498	10.7	Dr	RU Lib			498	10.3	Dr	504	6.1	L	530	5.9	Kl
500	9.5	Ch	504	10.7	Dr	*152714*			505	10.5	Dr	504	5.8	Kn	531	6.0	Sp
503	9.4	Pt	S Aps			495	10.6	L	Z Lib			504	6.1	Pt	531	6.2	Pt
503	10.1	L	*145971*			497	10.6	An	*154020*			505	6.0	L	533	6.1	Kl
511	10.0	Be	461	[13.4	Bl	497	10.5	Be	470	[12.7	Bl	505	6.2	Lj	534	6.2	Sb
511	10.0	An	463	[13.2	En	503	10.8	L	R CrB			505	6.0	Kd	X CrB		
512	9.9	Kz	466	[13.4	Ht	503	10.6	Pt	154428			505	6.2	Pt	154536		
512	10.0	Eb	468	[13.4	Sm	517	11.1	L	407	6.2	Kn	506	6.1	Ah	402	9.9	Br
512	10.4	Ed	473	[13.2	En	R Nor			443	5.7	Kn	506	6.2	Gy	405	10.0	Br
515	9.9	L	475	[13.2	En	*152849*			443	6.1	Kd	507	6.1	Pt	409	10.2	Br
			479	[13.2	En	461	8.9	Bl	453	6.0	Kd	508	6.0	L	413	10.3	Br

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1928.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
X CrB			R Her			RU Her			U Her			W Her			RS Sco		
154536			160118			160625a			162119			163137			*164844*		
523	13.4	B	510[	10.3	Sc	524	9.6	B	508	7.9	Kl	524	11.6	B	498	6.9	Dr
R Ser			524[	13.3	B	526	10.1	Kz	511	7.7	Pc	R Dra			505	6.8	Dr
154615			U Ser			527	10.1	Sc	512	8.2	Hs	163266			RR Sco		
492[	13.2	Ch	160210			R Sco			514	7.5	Ah	492	11.8	Ch	*165030*		
V CrB			503	11.7	Pt	*161122a*			516	7.4	Ah	493	11.7	Lj	461	11.3	Bl
154639			511	11.8	An	461	11.9	Bl	517	7.4	Ah	497	11.3	Lj	464	11.7	En
502	7.8	Lg	X Sco			464	11.9	En	521	7.6	Fd	498	11.4	Lj	466	11.5	Ht
503	6.9	Pt	*160221*			466	11.5	Ht	522	7.8	Kl	502	11.2	Lj	468	12.0	Sm
504	8.2	Kd	470	12.6	Bl	468	11.9	Sm	522	7.4	Hs	503	10.8	Pt	469	11.6	Bl
513	7.7	Lg	480	11.3	Bl	469	11.7	Bl	523	7.7	Fd	505	11.0	Lj	473	11.7	En
520	7.2	Sc	SX Her			473	12.2	En	524	7.8	Fd	510	10.8	Lj	475	11.7	Ht
523	7.5	B	160325			475	12.2	Ht	524	7.7	Kl	511	10.7	Pc	480	11.3	Bl
526	7.2	Sc	402	8.5	Br	480	12.2	Bl	524	7.5	Hs	514	10.7	Lj	498	10.9	Dr
527	7.6	Lg	405	8.5	Br	503	12.8	Pt	524	7.5	B	516	10.6	Lj	505	11.2	Dr
R Lib			409	8.6	Br	S Sco			526	7.4	Kz	517	9.8	Ah	RV Her		
154715			413	8.6	Br	*161122b*			526	7.5	Jo	527	9.7	Hs	165631		
503[	11.2	L	415	8.7	Br	461	11.5	Bl	527	7.9	Hs	527	9.1	Jo	503	13.6	Pt
R Lup			419	8.7	Br	464	11.5	En	530	7.7	Kl	530	9.0	Jo	RT Sco		
154736			469	8.4	Br	466	11.2	Ht	533	7.8	Kl	TX Dra			*165636*		
464	11.8	En	478	8.0	Br	468	11.5	Sm	Y Sco			163360			469[	12.1	Bl
473	11.0	En	482	8.0	Br	469	11.4	Bl	*162319*			409	7.7	Br	R Oph		
498	10.4	Dr	483	7.9	Br	473	11.9	En	498	14.0	L	415	7.7	Br	*170215*		
505	10.5	Dr	484	7.9	Br	475	11.9	Ht	505[	14.5	L	478	7.4	Br	493	8.2	Ch
RR Lib			486	7.9	Br	480	12.3	Bl	SS Her			482	7.6	Br	501	8.0	Ch
155018			495	8.2	L	W CrB			162807			483	7.5	Br	503	8.0	Pt
496	8.9	L	502	8.2	L	161138			495	11.6	An	484	7.6	Br	RT Her		
503	9.2	L	503	8.1	Pt	402	10.9	Br	495	11.6	L	486	7.5	Br	170627		
503	8.5	Ch	504	8.0	Pt	413	11.2	Br	497	11.4	Be	RR Oph			503	11.9	Pt
503	8.8	Pt	505	8.3	Pt	523	11.4	B	502	11.8	L	*164319*			523	12.6	B
512	9.1	Sp	507	8.1	Pt	W Oph			503	12.0	Pt	503	12.6	Pt	RW Sco		
517	9.6	L	510	8.3	Pt	*161607*			512	12.3	B	S Her			*170833*		
RZ Sco			511	8.2	Pt	495	11.8	Be	517	12.4	L	164715			461	10.8	Bl
155823			512	8.4	L	495	11.8	An	T Oph			492	8.5	Ch	469	10.8	Bl
464	10.8	En	515	8.2	Pt	498	11.8	L	*162815*			492	8.7	Ah	480	10.3	Bl
466	10.8	Ht	517	8.5	Pt	502	12.0	Lg	470[	13.1	Bl	493	8.7	Ah	Z Oph		
468	10.4	Sm	518	8.6	Pt	503	12.1	Ch	498	14.1	L	495	8.8	Ah	171401		
473	9.8	En	523	8.4	Pt	503	12.5	Pt	S Oph			497	8.7	Ah	502	8.9	Lg
475	10.0	Ht	524	8.5	Pt	504	12.0	L	*162816*			503	8.6	Ah	503	9.0	Ah
486	9.1	Ht	527	8.6	Pt	513	12.5	Lg	461	9.6	Bl	503	8.3	Pt	505	8.9	Pt
503	8.5	Pt	528	8.6	Pt	527	12.8	Lg	469	9.8	Bl	506	8.4	Ah	506	8.9	Ah
Z Sco			529	8.5	Pt	V Oph			480	10.4	Bl	508	8.3	Ah	508	8.9	Ah
160021			531	8.6	Pt	*162112*			W Her			514	8.0	Ah	513	8.3	Lg
461	10.4	Bl	W Sco			503	8.4	Pt	163137			516	7.9	Ah	517	8.5	Ah
464	10.3	En	*160519*			U Her			402	9.7	Br	517	7.9	Ah	524	8.9	Sp
466	10.3	Ht	461	11.6	Bl	162119			409	8.8	Br	523	7.9	B	527	8.4	Lg
468	9.9	Sm	469	11.6	Bl	485	8.9	Ch	413	8.6	Br	526	7.8	Jo	RS Her		
469	10.0	Bl	480	12.0	Bl	492	8.5	Ah	415	8.4	Br	526	7.8	Kz	171723		
473	10.3	En	RU Her			494	8.2	Ah	469	9.0	Br	530	7.9	Jo	502	12.3	Lg
475	10.2	Ht	160625			497	8.2	Ah	478	9.6	Br	RS Sco			505	12.0	Pt
480	10.0	Bl	485	8.2	Ch	499	8.2	Kl	482	9.6	Br	*164844*			513	12.1	Lg
486	10.2	Ht	495	8.5	L	501	8.2	Kl	482	9.1	Ch	461	10.7	Bl	523	11.6	B
495	10.1	An	502	8.6	L	502	8.4	Hs	483	9.7	Br	464	10.9	En	527	11.5	Lg
495	9.9	L	503	8.2	Pt	503	8.0	Kl	484	9.7	Br	466	10.9	Ht	S Oct		
503	9.8	L	511	9.4	Pc	503	7.6	Ah	486	9.7	Br	468	10.7	Sm	*172486*		
519	9.5	L	512	8.7	L	503	7.5	Pt	492	9.8	Ch	469	10.6	Bl	461	7.6	Bl
R Her			523	9.5	Fd	506	7.5	Ah	503	11.0	Pt	473	10.2	En	465	8.1	En
160118			524	9.5	Fd	506	7.6	Jo	503	10.5	Pc	475	10.1	Ht	466	8.2	Ht
492	12.9	Ch	524	9.5	Sp	508	7.6	Ah	512	11.2	Sp	482	8.6	Ht	468	8.4	Sm

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S OCT	RY HER	X DRA	X OPH	R SCT	R SCT
172486	175519	180666	183308	*184205*	*184205*
470 8.0 Bl	504 9.5 Kz	527[10.9 Sc	505 6.6 L	503 5.7 Lg	527 4.9 Pt
475 8.3 En	505 9.0 Pt	Nov OPH	505 6.5 Pt	503 5.7 L	527 5.2 Wd
475 8.4 Ht	523 9.8 B	180911	506 6.7 Jo	503 5.9 Lj	528 5.1 Pt
481 8.4 Bl	V DRA	505[12.5 Pt	515 6.5 L	504 5.8 Lg	528 5.0 Sc
482 9.0 Ht	175654	TV HER	526 7.2 Jo	504 5.7 Pt	529 5.9 Hu
498 9.7 Dr	504 9.9 Kz	181031	526 6.9 Kz	504 6.0 Kd	529 5.1 Sp
505 10.1 Dr	505 10.0 Pt	495 10.3 L	530 6.9 Jo	504 6.2 Kz	529 5.2 Pt
RU OPH	R PAV	505 10.3 L	RS DRA	505 5.7 Ch	530 5.2 Pt
172809	*180363*	513 10.9 L	184074	505 5.8 Lg	530 5.0 Jo
495 10.5 Be	465 8.7 En	RY OPH	409 9.4 Br	505 6.1 Kd	531 5.2 Sp
495 10.8 An	466 9.3 Ht	181103	413 9.4 Br	505 5.9 Lj	531 5.2 Pt
505 11.0 Pt	467 9.1 Sm	492 8.5 Ah	469 10.3 Br	505 5.7 Pt	RW LYR
RT SER	475 9.3 Ht	494 8.4 Ah	478 10.3 Br	506 5.8 Gy	184243
173212	476 8.9 En	497 8.4 Ah	483 10.4 Br	507 5.7 Pt	525 13.8 B
495 12.4 L	482 9.4 Ht	503 8.0 Ah	484 10.4 Br	508 5.8 Lg	Nov AQL
503 12.5 L	498 10.5 Dr	505 8.2 Pt	486 10.4 Br	508 5.7 Kd	184300
517 12.5 L	505 10.7 Dr	506 8.1 Ah	RV LYR	509 5.9 Lg	494 10.6 Ch
RU SCO	T HER	508 8.3 Ah	184134	509 5.7 Be	502 10.8 Lg
173543	180531	516 8.9 Ah	505 11.5 Pt	509 5.7 L	503 11.5 Pt
461 10.9 Bl	492 7.6 Ah	526 9.2 Kz	R SCT	509 6.0 Gb	509 10.9 Lg
470 10.7 Bl	493 7.4 Ah	W LYR	*184205*	510 5.5 Sc	510 10.9 Lg
480 10.0 Bl	495 7.2 Ah	181136	433 5.9 Kd	510 5.7 An	510 11.7 Pt
SV SCO	495 7.4 L	505 12.0 Pt	443 6.8 Kd	510 5.8 Wd	513 10.8 Lg
174135	495 7.4 An	509 11.8 An	453 5.6 Kd	510 5.9 Lg	518 11.0 Lg
461 10.7 Bl	495 7.0 Be	525 9.7 B	465 5.5 Kd	510 5.5 Lj	523 11.5 Pt
470 10.5 Bl	497 7.2 Ah	526 9.5 Cl	469 5.5 Kd	510 5.5 Pt	524 11.0 Sp
480 9.8 Bl	500 7.0 Ch	529 9.6 Hu	472 5.5 Kd	511 5.4 Pt	527 10.9 Lg
W PAV	502 7.4 Ah	RV SGR	475 5.9 Kd	511 5.5 Pc	529 11.3 Pt
174162	502 7.2 Hs	*182133*	480 5.7 Kd	511 5.0 Be	RX LYR
461 11.6 Bl	503 7.2 Ah	461 7.9 Bl	481 5.6 Ch	511 5.4 An	185032
465 12.3 En	504 7.1 Kz	470 8.1 Bl	485 5.5 Ch	512 5.3 Sc	505 13.0 Pt
466 11.9 Ht	505 7.4 L	480 7.9 Bl	487 5.6 Kd	512 5.4 Sp	506 12.9 Ch
467 12.6 Sm	505 7.4 Kd	498 8.1 Dr	490 5.7 Kd	513 6.0 Lg	S CRA
470 11.6 Bl	505 7.6 Pt	505 7.9 Dr	491 5.7 Kd	514 5.5 Lj	*185437a*
475 12.5 Ht	506 7.4 Ah	509 8.9 Lg	491 5.9 Lj	515 5.5 Lj	461 11.6 Bl
476 12.3 En	508 7.4 Ah	SV HER	492 5.7 Kd	515 5.0 Pt	470 12.2 Bl
481 12.2 Bl	510 8.0 Sc	182224	493 5.9 Lj	515 5.1 L	480 11.5 Bl
RS OPH	511 7.9 Pc	495[13.0 Be	494 5.9 Lj	516 5.3 Sc	ST SGR
174406	512 7.8 Hs	505[14.1 L	494 5.8 Be	516 5.4 Lj	*185512a*
505 11.2 Pt	512 7.6 L	514[12.7 An	494 5.8 Ch	517 5.0 Pt	481 9.2 Ch
U ARA	512 7.5 Ah	523 12.3 B	495 6.0 An	518 5.3 Sc	495 10.3 L
174551	513 7.9 Kd	T SER	495 5.7 L	518 5.8 Lg	501 11.0 Ch
465 8.6 En	516 7.8 Ah	182306	495 6.2 Kd	518 4.9 Lj	502 10.2 Lg
468 8.8 Sm	517 7.7 Ah	504 10.0 Kz	495 5.9 Lj	518 5.1 Pt	505 11.0 L
475 10.4 En	520 8.2 Sc	505 9.8 Pt	497 5.9 Lj	520 5.4 Pt	513 10.9 Lg
RT OPH	521 8.4 Fd	510 9.7 Lg	497 6.0 Kd	520 5.1 Sc	515 11.2 L
175111	522 8.0 Hs	524 9.8 Sp	497 5.9 Be	521 5.4 Fd	527 11.7 Lg
524[13.5 B	523 7.8 Fd	527 9.8 Lg	497 5.9 An	521 5.1 Sp	R CRA
T DRA	524 7.5 Fd	RZ HER	498 5.9 Lj	521 5.5 Wd	*185537a*
175458a	524 8.5 B	183225	499 5.9 Kd	522 5.2 Pt	461 11.4 Bl
502 12.7 Lg	526 8.5 Jo	502 12.8 Lg	500 6.0 An	523 5.3 Fd	470 11.9 Bl
UY DRA	526 8.5 Sc	513 13.0 Lg	501 5.7 Ch	524 5.3 Fd	480 12.2 Bl
175458b	527 8.1 Hs	526[12.2 Kz	501 6.0 Kd	524 5.1 Pt	T CRA
502 10.9 Lg	529 8.4 Hu	X OPH	502 6.0 Kd	525 4.9 Pt	*185537b*
RY HER	530 8.4 Jo	183308	502 5.9 Lj	525 5.5 Pc	470[13.0 Bl
175519	W DRA	495 6.4 L	502 5.8 Lg	526 5.0 Sc	Z LYR
482 9.9 Ch	180565	497 6.9 An	503 5.7 Pc	526 5.1 Jo	185634
501 9.2 Ch	527[11.6 Sc	497 6.7 Bc	503 5.9 Pt	527 5.9 Lg	517 13.8 L

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J.D.	Est.	Obs.
Z LYR		
185634		
525	14.0	B
RT LYR		
185737		
506	10.4	Ch
R AQL		
190108		
492	8 8	Ah
493	9.0	Ah
495	9.1	Ah
498	9.5	Ah
501	9.3	Ch
503	9.4	Ah
505	8.7	Pt
506	9.6	Ah
524	10.0	B
524	9.9	Kl
525	9.9	Kl
530	10.0	Kl
V LYR		
190529a		
505	12.6	Pt
RX SGR		
190818		
466	10.0	En
476	10.1	En
481	9.9	Ch
502	10.8	Lg
505	11.5	Pt
513	10.3	Lg
527	10.8	Lg
RW SGR		
190819a		
466	9.3	En
476	9.0	En
481	9.5	Ch
502	9.4	Lg
505	9.4	Pt
513	9.3	Lg
527	9.5	Lg
TY AQL		
190907		
505	10.2	Pt
526	10.6	Kz
S LYR		
190925		
495	14.4	L
504	14.5	L
517	14.5	L
X LYR		
190926		
505	8.8	Pt
RS LYR		
190933a		
505	11.8	Pt
506	11.7	Ch
RU LYR		
190941		
502	13.5	Lg
RU LYR		
190941		
513	12.9	Lg
527	12.8	Lg
U DRA		
190967		
505	13.2	Pt
W AQL		
191007		
481	11.4	Ch
505	11.9	Pt
T SGR		
191017		
481	9.8	Ch
505	8.8	Pt
R SGR		
191019		
481	11.8	Ch
505	12.5	Pt
RY SGR		
191033		
461	6.2	Bl
465	6.9	En
466	6.7	Ht
467	6.5	Sm
470	7.0	Bl
475	6.7	Ht
479	6.5	En
481	6.2	Bl
482	6.5	Ht
491	5.9	L
492	5.8	L
495	5.9	L
496	6.5	Ch
497	6.3	An
498	6.3	Dr
498	6.0	L
499	6.1	L
502	6.6	Lg
503	6.2	L
503	6.4	Pt
504	6.0	L
504	6.5	Pt
504	6.8	Dr
505	7.0	Dr
505	6.7	Kd
505	6.1	L
505	6.6	Pt
507	6.5	Pt
507	6.4	L
508	6.6	Kd
508	6.4	L
509	6.8	Lg
509	6.7	L
510	6.8	Lg
510	6.3	Pt
510	6.8	L
511	6.3	Pt
515	7.0	L
516	6.8	L
RY SGR		
191033		
517	6.5	Pt
519	6.5	L
524	6.4	Pt
526	6.3	Pt
529	6.4	Pt
531	6.4	Pt
TY SGR		
191124		
461	11.5	Bl
465	11.5	En
470	12.0	Bl
475	11.7	En
481	12.1	Bl
498	12.7	Dr
505	13.0	Dr
S SGR		
1913190a		
470	11.2	Bl
481	10.9	Bl
505	11.2	Pt
SW SGR		
191331		
470	12.9	Bl
TZ CYG		
191350		
505	10.5	Pt
526	10.8	Sp
U LYR		
191637		
505	11.0	Pt
AF CYG		
192745		
413	7.3	Br
415	7.3	Br
478	7.1	Br
482	7.1	Br
484	7.2	Br
TY CYG		
192928		
505	12.6	Pt
506	12.4	Ch
RT AQL		
193311		
502	12.5	Lg
506	12.0	Ch
513	11.8	Lg
524	10.0	B
527	10.2	Lg
R CYG		
193449		
503	12.1	Ch
507	12.5	Pt
512	12.6	Sb
526	12.7	Sb
526	12.7	Kz
RV AQL		
193509		
502	13.4	Bl
513	13.3	Bl
527	13.1	Bl
TT CYG		
193732		
527	8.0	Hu
T PAV		
193972		
461	10.6	Bl
465	10.8	En
466	10.5	Ht
467	10.6	Sm
470	9.1	Bl
475	8.9	Ht
475	8.6	En
481	8.2	Bl
482	8.3	Ht
498	7.9	Dr
505	8.0	Dr
RT CYG		
194048		
503	10.9	Ch
507	9.8	Pt
526	8.4	Jo
526	8.7	Kz
529	8.3	Hu
530	8.6	Jo
TU CYG		
194348		
500	11.1	Ch
503	11.2	Ch
507	11.7	Pt
X AQL		
194604		
507	12.3	Pt
χ CYG		
194632		
433	7.3	Kd
443	7.8	Kd
453	8.3	Kd
469	8.6	Kd
494	9.5	Ch
494	9.8	Ah
495	10.4	An
498	10.2	Ah
503	10.5	Ah
507	10.3	Pt
514	11.0	An
524	11.0	Sp
524	10.4	Wd
526	11.4	Kz
S PAV		
194659		
465	7.9	En
475	7.9	En
498	8.2	Dr
505	8.0	Dr
RR SGR		
194929		
462	8.3	Bl
470	8.7	Bl
481	9.0	Bl
498	9.6	Dr
505	9.9	Dr
RU SGR		
195142		
462	12.2	Bl
465	12.5	En
466	12.1	Ht
467	12.1	Sm
470	12.4	Bl
475	12.5	En
475	12.5	Ht
RR AQL		
195202		
524	10.6	Sp
524	10.6	B
RS AQL		
195308		
524	12.2	B
Nov CYG		
195553		
503	12.2	Pt
514	12.2	Pt
524	12.2	Pt
529	12.2	Pt
Z CYG		
195849		
504	10.8	Ch
507	10.4	Pt
530	8.9	Sc
S TEL		
195855		
465	12.6	En
475	12.6	En
470	12.9	Bl
SY AQL		
200212		
495	14 5	L
504	14.2	L
507	12.7	Pt
515	13.5	L
527	13.2	Lg
BU CYG		
200250		
493	11.2	Lj
497	11.1	Lj
502	11.0	Lj
505	10.9	Lj
510	10.7	Lj
512	10.8	Lj
514	10.8	Lj
517	10.7	Lj
R CAP		
200514		
507	11.0	Pt
SV CYG		
200647		
527	9.0	Hu
530	9.5	Sc
S AQL		
200715a		
402	9.7	Br
409	9.8	Br
413	9.8	Br
415	9.8	Br
419	10.0	Br
469	10.7	Br
478	11.0	Br
482	11.2	Br
484	11.2	Br
486	11.2	Br
491	11.1	Br
507	10.9	Pt
510	10.4	Lg
524	9.8	B
526	10.1	Kz
526	9.6	Cl
527	9.7	Lg
RW AQL		
200715b		
507	9.1	Pt
510	8.9	Lg
524	9.3	B
526	9.2	Kz
526	9.2	Cl
527	8.4	Lg
R TEL		
200747		
470	14.0	Bl
RU AQL		
200812		
515	12.9	L
527	13.0	Lg
W CAP		
200822		
470	13.5	Bl
Z AQL		
200906		
507	9.5	Pt
526	11.3	Kz
R SGE		
200916		
524	10.1	B
526	10.1	Cl
RS CYG		
200938		
491	7.4	L
493	7.3	Ch
494	7.4	Ch
495	7.5	L
496	7.3	Ch
500	7.3	Ch
501	7.5	L
503	7.4	L
506	8.0	Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RS CYG	U CYG	V CYG	R VUL	T CEP	W CYG
200938	201647	203847	205923a	210868	213244
507 7.1 Pt	493 9.0 Ah	507 10.2 Ah	492 8.7 Ah	497 6.6 Ah	489 6.3 Kd
510 7.2 L	494 9.3 Ah	507 8.8 Pt	494 8.6 Ah	500 6.7 Ch	491 6.3 Kd
511 7.0 Jo	495 9.3 Ah	Y AQR	497 8.6 Ah	502 6.4 Ah	492 6.3 Kd
517 7.4 L	498 9.7 Ah	*203905*	500 8.3 Ch	503 6.4 Ah	492 6.0 L
520 7.3 Sc	507 9.8 Ah	507 11.7 Pt	502 8.4 Ah	504 5.8 Kz	494 5.9 L
523 7.8 Sb	507 7.8 Pt	510 11.4 An	503 8.4 Ah	506 6.5 Gy	495 6.3 Kd
524 7.3 Sp	511 9.8 Wd	526 10.7 Sb	504 8.3 Kz	506 6.5 Jo	497 6.3 Kd
526 7.2 Jo	511 9.0 Jo	T DEL	506 8.4 Ah	506 6.5 Ah	498 5.8 L
526 7.1 Sc	517 9.9 Ah	204016	507 8.0 Pt	507 6.7 Pt	500 6.4 Kd
530 7.3 Jo	524 10.0 Sp	494[13.3 An	508 8.4 Ah	508 6.3 Ah	501 6.3 Kd
537 7.5 Sb	524 9.3 Fd	504[12.8 Kz	511 8.3 Jo	511 6.3 Jo	501 6.0 L
R DEL	526 9.4 Kz	509[13.3 An	512 8.4 Ah	512 6.2 Ah	502 6.5 Kd
201008	526 8.8 Jo	V AQR	516 8.4 Ah	514 6.1 Ah	503 5.9 L
492 8.2 Ah	530 8.8 Jo	204102	517 8.4 Ah	516 6.1 Ah	504 6.6 Kd
494 8.3 Ah	U MIC	507 8.3 Pt	520 8.6 Ah	517 6.0 Ah	509 5.9 L
494 8.3 An	*202240*	512 8.6 Kz	526 8.4 Jo	520 6.0 Ah	511 6.6 An
495 8.0 L	462 8.8 Bl	512 8.6 Eb	530 8.5 Jo	523 6.3 Sb	513 6.6 Kd
497 8.0 Ah	470 8.8 Bl	512 8.6 Ed	RS CAP	526 6.0 Jo	518 5.9 L
502 8.2 Ah	481 9.1 Bl	W AQR	*210116*	527 6.3 Gy	520 6.0 L
503 8.1 Ah	498 9.9 Dr	*204104*	495 7.9 An	537 6.0 Sb	S CEP
504 8.1 L	505 10.0 Dr	495 11.3 L	510 7.9 An	RR AQR	213678
504 8.0 Kz	RW CYG	504 11.7 L	530 8.3 Sc	*210903*	504 11.4 Kz
506 8.1 Ah	202539	512 11.7 Kz	V CAP	504 9.6 Kz	505 10.9 Pt
507 8.0 Pt	494 9.6 An	512 11.7 Eb	*210124*	505 9.9 Pt	RU CYG
508 8.2 Ah	509 9.4 An	512 11.8 Ed	462 9.6 Bl	X PEG	213753
511 8.4 An	520 9.1 Sc	515 11.6 L	470 9.6 Bl	211614	500 8.0 Ch
515 8.0 L	526 9.4 Sc	U CAP	481 8.9 Bl	504 11.5 Kz	505 7.9 Pt
516 8.4 Ah	ST CYG	*204215*	498 9.3 Dr	507 11.3 Pt	RV CYG
517 8.4 Ah	202954	470[13.6 Bl	505 9.3 Dr	T CAP	213937
520 8.4 Ah	507 10.9 Pt	524 11.7 B	TW CYG	*211615*	491 6.8 L
524 8.8 Sp	529 11.9 Hu	V DEL	210129	470 11.8 Bl	494 6.9 L
RT CAP	V VUL	204318	526 11.0 Sp	481 10.8 Bl	499 7.0 L
201121	203226	527[13.5 Lg	X CAP	481 11.4 Ch	500 6.9 L
443 7.5 Kd	507 8.7 Pt	T AQR	*210221*	526 9.5 Kz	505 6.5 Pt
475 7.5 Kd	R MIC	*204405*	462 11.7 Bl	S MIC	507 6.9 L
493 7.6 Kd	*203429*	494[10.7 Ch	470 11.9 Bl	*212030*	518 6.9 L
498 7.6 Kd	462 10.8 Bl	507 12.7 Pt	RS AQR	462 9.4 Bl	520 6.9 L
504 7.5 Kd	470 11.5 Bl	513 12.8 Lg	*210504*	465 10.0 En	527 7.2 Hu
509 7.6 Kd	481 12.6 Bl	526 12.9 Sb	495 11.9 L	467 9.7 Sm	RR PEG
530 7.8 Sc	Y DEL	RZ CYG	504 12.5 L	470 10.0 Bl	214024
SX CYG	203611	204846	507 13.2 Pt	476 10.7 En	504 9.2 Kz
201130	527[13.3 Lg	507 13.2 Pt	517 13.5 L	481 11.0 Bl	505 9.1 Pt
507 13.7 Pt	S DEL	S IND	Z CAP	498 12.6 Dr	513 9.7 Lg
RT SGR	203816	*204954*	*210516*	505 12.8 Dr	527 10.1 Lg
201139	493 11.8 Lj	462 10.5 Bl	507 10.6 Pt	Y CAP	R GRU
470 12.9 Bl	497 11.9 Lj	470 10.5 Bl	525 11.2 B	*212814*	*214247*
498 11.1 Dr	502 11.9 Lj	481 10.8 Bl	526 11.3 Kz	470[12.9 Bl	462 11.2 Bl
505 11.0 Dr	504 12.1 Kz	498 12.1 Dr	R EQU	W CYG	465 11.9 En
WX CYG	505 12.0 Lj	505 12.5 Dr	210812	213244	466 12.0 Ht
201437b	507 12.0 Pt	X DEL	504 10.0 Kz	433 6.1 Kd	467 11.6 Sm
495 12.8 L	509 12.0 Lj	205017	507 9.8 Pt	443 6.0 Kd	470 12.1 Bl
501 13.0 L	510 12.0 Lj	504 9.0 Kz	512 10.2 Cl	453 6.0 Kd	475 12.4 Ht
503 12.5 L	514 11.9 Lj	507 9.4 Pt	T CEP	465 6.0 Kd	476 12.4 En
507 12.3 Pt	518 11.9 Lj	RR CAP	210868	469 6.2 Kd	482 12.9 Ht
509 12.5 L	V CYG	*205627*	482 7.2 Ch	472 6.3 Kd	498 13.2 Dr
517 12.3 L	203847	498 10.1 Dr	492 6.7 Ah	475 6.2 Kd	505 13.7 Dr
	492 10.9 Ch	505 9.7 Dr	493 6.7 Ah	480 6.2 Kd	
	498 10.0 Ah		495 6.6 Ah	487 6.3 Kd	

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V PEG	S GRU	R LAC	W PEG	R AQR	V CET
215605	*221948*	223841	231425	*233815*	*235209*
504 10.1 Kz	475 12.6 Ht	496[14.0 L	508 8.8 Kl	482 8.4 Ch	503 10.2 L
505 10.2 Pt	476 12.2 En	503[14.0 L	514 9.0 An	482 8.3 Ht	513 9.8 L
524 11.1 Sp	482 12.6 Ht	506[13.0 Ch	522 8.9 Kl	494 8.9 An	R TUC
U AQR	498 12.7 Dr	511[14.0 L	524 9.0 Kl	496 8.5 L	*235265*
215717	505 12.8 Dr	RW PEG	530 9.0 Kl	496 8.8 Ch	465 12.0 En
505 11.0 Pt	RV PEG	225914	S PEG	503 8.9 L	468 12.4 Sm
RT PEG	222129	505 10.6 Pt	231508	505 8.7 Kd	475 10.2 En
215934	512[12.5 B	524[11.2 Sp	496 9.4 Ch	505 8.6 Pt	R CAS
481 11.4 Ch	S LAC	R PEG	504 9.9 Kz	509 8.7 Kd	235350
505 11.3 Pt	222439	230110	505 9.7 Pt	510 8.7 L	492 9.9 Ah
RZ PEG	496 13.7 L	494 9.8 Ah	510 9.9 B	510 8.3 An	495 9.5 Ah
220133b	503 13.5 L	498 10.1 Ah	V PHE	512 8.6 Eb	497 9.4 Ah
505 10.2 Pt	505 13.0 Pt	501 10.0 Kl	*232746*	512 8.5 Ed	503 8.8 Ah
T PEG	506 13.4 Ch	503 10.0 Ah	466 12.3 Ht	524 9.1 Sp	506 8.8 Ah
220412	510 13.4 L	505 10.6 Pt	475 12.7 Ht	527 8.8 Sc	506 8.9 Gy
481[13.2 Ch	R IND	508 10.0 Kl	498 13.9 Dr	Z CAS	508 8.4 Ah
496 14.3 L	*222867*	510 10.9 Sf	505 13.6 Dr	233956	514 8.2 Ah
503[13.2 L	470 14.0 Bl	513 10.6 Lg	Z AND	510 10.2 B	516 7.8 Ah
512[13.7 L	498 12.8 Dr	521 11.1 Sf	232848	RR CAS	517 7.5 Ah
RS PEG	505 12.6 Dr	524 10.4 Kl	496 10.0 Ch	235053	527 7.6 Gy
220714	T TUC	527 11.1 Lg	505 9.6 Pt	496 10.5 Ch	Z PEG
505 12.7 Pt	*223462*	528 11.3 Sf	ST AND	510 10.2 B	235525
T GRU	466 10.5 En	530 10.5 Kl	233335	R PHE	504 10.4 Kz
221938	466 10.6 Ht	V CAS	496 9.1 Ch	*235150*	505 10.4 Pt
465 10.6 En	468 10.9 Sm	230759	505 8.8 Pt	498 8.1 Dr	Y CAS
467 10.9 Sm	475 11.1 En	505 11.3 Pt	513 9.2 Lg	505 8.3 Dr	235855
476 11.0 En	475 10.9 Ht	510 11.0 B	527 9.6 Lg	V CET	510 12.8 B
S GRU	482 11.2 Ht	W PEG	534 9.0 Hu	*235209*	SV AND
221948	498 12.5 Dr	231425	R AQR	470 12.5 Bl	235939
465 12.2 En	505 12.6 Dr	499 8.4 Kl	*233815*	481 10.9 Bl	505 8.8 Pt
466 12.4 Ht		500 8.7 Ch	470 8.3 Bl	496 9.7 L	516 8.6 Sc
467 12.2 Sm		501 8.5 Kl	475 8.6 Ht		534 10.0 Hu
		503 8.7 Kl	481 8.4 Bl		

RAPIDLY VARYING IRREGULAR VARIABLES.

Star J.D.	Est.Obs	J.D.	Est.Obs.	Star J.D.	Est.Obs.	J.D.	Est.Obs.
005840 RX ANDROMEDAE—				074922 U GEMINORUM—			
5503.7	[12.2 Pt	5514.9	[12.4 Pt	5491.6	[13.0 L	5508.6	9.2 L
5505.7	12.6 Pt	5524.6	11.5 Pt	5492.6	[13.0 L	5509.6	9.3 L
5506.8	[11.7 Pt	5528.7	[12.4 Pt	5496.6	[13.3 L	5510.6	9.4 L
5507.7	[11.7 Pt	5529.6	[12.4 Pt	5497.6	[13.3 L	5511.9	9.3 L
5510.7	11.5 Pt	5530.7	13.0 Pt	5498.6	[13.7 L	5511.9	9.3 Pt
5511.7	[12.4 Pt	5531.7	13.0 Pt	5499.6	[13.7 L	5512.6	9.7 L
060547 SS AURIGAE—				5500.6	[13.7 L	5513.6	9.4 L
5491.6	[13.3 L	5506.6	12.8 L	5501.6	[13.3 L	5514.6	9.5 L
5492.6	[13.3 L	5507.6	13.0 L	5502.6	[13.7 L	5514.9	9.2 Pt
5494.6	[13.9 L	5508.6	13.7 L	5503.6	[13.7 L	5515.6	9.9 L
5496.6	[13.9 L	5509.6	14.5 L	5504.6	10.3 L	5516.6	10.4 L
5497.6	[11.5 L	5510.6	14.4 L	5505.6	9.6 L	5517.6	10.6 L
5498.6	[11.5 L	5512.6	[14.0 L	5506.6	8.9 L	5518.6	11.2 L
5499.6	14.7 L	5513.6	[14.0 L	5507.6	9.1 L	5520.6	12.8 L
5500.6	14.0 L	5515.6	14.3 L	202946 SZ CYGNI—			
5501.6	10.8 L	5516.6	14.7 L	5503.7	9.4 Pt	5511.7	9.1 Pt
5502.6	10.7 L	5517.6	[13.9 L	5504.7	9.5 Pt	5514.9	9.2 Pt
5503.6	10.8 L	5518.6	[13.9 L	5505.7	9.4 Pt	5515.7	9.6 Pt
5504.6	11.0 L	5520.6	[13.9 L	5506.8	9.1 Pt	5518.7	9.7 Pt
5505.4	11.7 Ch	5527.8	[11.6 Sp	5507.7	8.8 Pt	5520.7	9.2 Pt
5505.6	12.0 L			5510.7	9.5 Pt	5522.7	8.7 Pt

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.Obs	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
202946 SZ CYGNI—					213843 SS CYGNI—				
	5523.6	9.0 Pt	5528.6	9.6 Pt		5506.8	9.1 Pt	5514.9	11.4 Pt
	5524.6	9.1 Pt	5529.6	9.5 Pt		5507.2	8.3 Lg	5515.2	11.1 L
	5525.7	9.4 Pt	5530.7	9.5 Pt		5507.3	8.9 L	5515.3	11.6 Lj
	5527.6	9.3 Pt	5531.7	9.7 Pt		5507.4	9.1 Ah	5515.4	11.6 An
	5527.6	9.0 Hu				5507.7	9.1 Pt	5515.7	11.5 Pt
213843 SS CYGNI—						5508.3	8.9 L	5516.3	11.7 Lj
	5483.2	11.7 Ch	5498.4	11.6 Ah		5508.3	9.2 Ah	5516.4	11.6 L
	5491.4	11.8 Lj	5499.3	11.6 Lj		5509.3	9.5 An	5517.3	11.7 Lj
	5491.6	11.6 L	5499.5	11.8 Ah		5509.3	9.0 L	5517.4	11.6 L
	5492.1	11.8 Ch	5499.6	11.3 L		5509.3	9.2 Lj	5517.7	11.7 Pt
	5492.3	11.8 Lj	5500.3	10.1 L		5509.9	9.7 Lg	5518.2	11.5 L
	5492.4	11.8 Ah	5500.5	10.2 An		5510.3	9.3 Lj	5518.3	11.8 Lj
	5492.6	11.6 L	5501.3	9.7 L		5510.3	9.2 L	5518.8	11.8 Lg
	5493.3	11.8 Ah	5501.4	9.7 An		5510.5	9.5 An	5519.3	11.7 L
	5493.3	11.9 Lj	5502.3	9.6 L		5510.5	9.4 B	5520.5	12.0 L
	5494.3	11.7 Lj	5502.3	9.7 Lj		5510.7	9.8 Pt	5520.7	11.7 Pt
	5494.3	11.8 Ah	5502.5	9.5 Ah		5510.8	10.2 Lg	5522.7	11.7 Pt
	5494.5	11.7 L	5502.8	9.5 Lg		5511.4	9.9 An	5523.5	11.9 Cl
	5494.6	12.1 An	5503.3	9.4 L		5511.6	10.0 Pc	5523.6	11.7 Pt
	5495.3	11.8 Ah	5503.3	9.5 Ah		5511.7	10.1 Jo	5524.6	11.7 Pt
	5495.3	11.8 Lj	5503.4	9.8 Lj		5511.7	10.1 Pt	5525.6	11.2 Pc
	5495.4	11.6 L	5503.7	9.8 Pt		5512.3	9.8 L	5525.7	11.7 Pt
	5495.4	11.8 An	5504.1	8.4 Ch		5512.5	10.2 Sp	5526.6	11.6 Cl
	5496.1	11.6 Ch	5504.3	9.1 L		5512.5	10.1 Ah	5526.6	11.3 Jo
	5496.3	11.6 L	5504.3	9.3 Lj		5512.6	10.3 B	5526.7	11.6 Sp
	5497.3	11.9 An	5504.6	9.4 Sp		5512.6	10.3 Lj	5527.6	11.7 Hu
	5497.3	11.8 Ah	5504.7	9.5 Pt		5512.6	10.2 Cl	5527.8	11.8 Lg
	5497.3	12.0 Be	5505.3	9.1 L		5513.4	10.4 L	5527.6	11.7 Pt
	5497.3	11.8 Lj	5505.5	9.2 Ah		5513.8	11.3 Lg	5528.7	11.8 Pt
	5497.4	11.5 L	5505.7	9.5 Pt		5514.3	11.0 Ah	5529.6	11.7 Pt
	5498.3	11.6 L	5506.3	8.9 Ah		5514.3	11.1 Lj	5530.7	11.6 Pt
	5498.3	11.7 Lj	5506.6	8.8 L		5514.3	11.0 An	5531.7	11.6 Pt

MONTHLY SUMMARY FOR OCTOBER, 1928.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	23	182	Kanamori	Kn	2	10
Ancarani	An	31	60	Kanda	Kd	12	82
Baldwin	Bl	97	198	Kohl	Kl	7	40
Benini	Be	14	20	Kurtz	Kz	45	45
Beyer	Br	14	106	Lacchini	L	68	415
Bouton	B	35	36	Leiner	Lj	11	107
Chandra	Ch	91	119	Logan	Lg	35	96
Clement	Cl	9	11	Peltier	Pt	180	310
Dartayet	Dr	61	99	Proctor	Pc	12	17
Ebert, D.	Ed	7	7	Schoenfeld	Sc	27	47
Ebert, M.	Eb	8	8	Smith, F. W.	Sf	9	17
Ensor	En	52	95	Smith, W. H.	Sm	45	46
Ford	Fd	9	22	Soberanes	Sb	10	18
Gaebler	Gb	2	2	Spears	Sp	31	36
Gregory	Gy	8	16	Waterfield	Wf	1	6
Haas	Hs	4	13	Webb	Wd	7	13
Houghton	Ht	29	73				
Hunter	Hu	15	15	Totals		35	385	2435
Jones	Jo	21	50				

SUMMARY OF ANNUAL REPORTS, 1912-1928.

Year	Observations	Stars	Observers
1912	6,180	175	19
1913	12,914	200	20
1914	14,506	255	28
1915	14,724	282	29
1916	11,261	290	30
1917	15,788	332	43
1918	16,112	380	34
1919	8,710	352	53
1920	9,099	399	69
1921	15,513	386	77
1922	16,994	372	72
1923	17,745	441	68
1924	19,484	450	70
1925	23,375	439	68
1926	17,990	434	74
1927	17,600	470	75
1928	23,144	500	78
Totals	261.039	520	340*

ANNUAL REPORT OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS FOR YEAR ENDING OCTOBER, 1928.

Observer	Initial	November	December	January	February	March	April	May-June	July-Aug.	September	October	Totals
Ahnert	Ah	..	..	..	..	..	..	46	159	93	182	480
Ancarani	An	4	8	22	29	8	40	15	26	..	..	152
Baldwin	Bl	191	185	182	164	122	132	413	378	199	198	2164
Bappu	Bf	40	..	32	91	84	58	59	64	22	..	450
Barry	By	28	12	26	67	69	72	11	109	..	..	394
Bashkaran	Bg	10	..	40	50	..	10	72	..	..	..	182
Benini	Be	12	10	..	..	..	..	..	62	31	20	135
Beyer	Br	..	..	..	..	..	..	167	114	..	106	387
Bouton	B	256	117	119	65	75	82	147	..	..	36	897
Brown, A. N.	Bn	4	8	3	13	10	2	7	4	12	..	63
Bunch	Bh	..	..	23	23	14	..	..	13	..	..	73
Chandra	Ch	..	154	172	190	205	166	178	233	53	119	1470
Cherrington	Cb	5	8	11	..	..	..	..	..	..	..	24
Clement	Cl	13	12	12	6	5	21	8	17	..	11	105
Dartayet	Dr	..	76	..	..	118	163	62	297	406	99	1221
Dawson	Dw	..	..	..	..	..	..	14	22	..	..	36
Ebert, M.	Eb	16	39	51	20	16	20	20	5	..	8	195
Ensor	En	117	86	96	85	62	69	142	209	95	95	1056
Ford	Fd	46	16	28	45	87	153	121	497	..	22	1015
Furuhata	Fu	..	..	49	..	..	..	79	..	..	..	128
Gaebler	Gb	10	3	5	3	5	17	6	20	3	2	74
Gallanti	Gt	..	..	..	..	29	19	5	17	29	..	99
Gomi	Go	..	..	..	..	25	8	20	12	..	..	65
Goodsell	Gs	..	5	2	..	2	6	..	6	4	..	25
Gregory	Gy	..	3	4	3	..	..	13	8	..	16	47
Haas	Hs	..	..	..	..	..	..	..	9	..	13	22
Hama	H	12	..	..	..	..	24	..	..	..	..	36
Houghton	Ht	106	101	92	86	82	78	161	119	75	73	973

*Approximate number of observers in the published reports of the A.A.V.S.O.

ANNUAL REPORT—Continued.

Observer	Initial	November	December	January	February	March	April	May-June	July-Aug.	September	October	Totals
Hunter	Hu	24	14	..	..	..	..	..	..	..	15	53
Iedema	Ie	30	10	16	..	..	..	..	..	..	..	56
Johnstone	Jn	..	..	..	..	..	..	6	10	4	..	20
Jones	Jo	58	29	54	26	15	42	92	86	44	50	496
Kanda	Kd	..	99	..	74	..	..	..	..	..	82	255
Kohl	Kl	..	32	8	5	11	10	11	..	21	40	138
Kurtz	Kz	16	39	51	20	16	20	20	15	44	45	286
Lacchini	L	108	109	39	98	337	26	75	352	378	415	1937
Lee	Lh	..	..	..	..	4	..	42	..	..	..	46
Leiner	Lj	..	..	..	..	..	..	..	145	82	107	334
Logan	Lg	2	67	75	112	71	82	86	188	119	96	899
Peltier	Pt	364	254	286	271	258	225	261	842	292	310	3363
Pickering	Pi	..	..	..	10	29	20	30	..	..	..	89
Prentice	Pn	1	8	16	7	3	2	..	..	..	..	37
Proctor	Pc	..	..	..	..	..	..	5	..	..	17	22
Rajchl	Rj	..	..	..	..	..	..	..	..	46	..	46
Rittenberg	Rt	25	..	22	..	20	..	..	..	..	..	67
Schoenfeld	Sc	..	..	..	..	..	..	..	..	8	47	55
Smith, F. W.	Sf	..	11	1	5	8	12	..	29	6	17	89
Smith, W. H.	Sm	115	128	77	86	118	69	82	169	33	46	923
Soberanes	Sb	4	7	..	..	..	..	..	32	10	18	71
Spears	Sp	48	20	20	39	36	57	26	89	..	36	372
Swanson	Sw	..	..	..	11	10	3	22	22	38	..	106
Waldo	Wl	..	..	..	9	20	23	..	..	..	..	52
Watkins	Wk	9	10	..	44	..	43	202	27	..	..	335
Waterfield	Wf	..	..	..	..	..	..	..	9	8	6	23
Webb	Wd	..	..	..	..	11	24	27	48	15	13	138
White	Wb	..	..	..	..	21	..	..	..	..	..	21
Whitney	Wy	..	..	..	..	..	5	5	76	..	..	86
Williams, R.	Wm	10	..	8	..	..	3	2	..	..	..	23
Yalden	Ya	24	5	..	11	..	..	..	..	..	..	40
Georgetown Coll.	GC	44	40	42	25	34	56	39	..	..	..	280
18 Others		33	7	6	..	7	4	..	20	15	17	109
Totals	78	1785	1732	1670	1789	2036	1863	2824	4800	2210	2435	23,144

success, with the following taking part: Dr. Shapley, describing the Variable Star Commission meetings of the I.A.U.; Miss Bigelow, the excursions to Kepler's birthplace and the Planetarium at Stuttgart; Mr. Campbell, his contacts with variable star people; and last, but by no means the least, the final wind-up by Mr. Elmer on his trip over, while there, and back, splendidly illustrated by original lantern slides.

Just preceding the symposium, Professor Mather, of the Department of Geology at Harvard, traced in a wonderfully clear style the connection between Geology and Astronomy.

With more than seventy members and their friends present, the meeting was voted a huge success and now the members are looking forward to the Washington meeting of the Association in May, 1929.

The Annual Summary of Observations is here appended and indicates increasing activity on the part of the Association. Germany is represented for the first time and this bespeaks a splendid future for us, for it is readily seen that the

observers from that section are destined to play an important part in our observing program.

When we consider the value of these twenty odd thousands of observations, coupled with an almost equal number from the French Association, as well as thousands made by the members of the English Association, it can be seen that amateur variable star observing is a worth-while proposition, and the material being thus gathered is by no means small or without real value.

LEON CAMPBELL, Recording Secretary.

November 8, 1928.

METEOR NOTES.

By CHARLES P. OLIVIER.

Since the last Meteor Notes reports have come in from Idaho, New Zealand, and Texas, the latter state, as is becoming usual, leading all other localities in the number of observers at work and of meteors reported. The writer also observed the Orionids one night here at the Flower Observatory. The reports continued to show an excellence far in excess of most received during previous years. However the writer feels disappointed that apparently so many of our members neglected the Orionid epoch, which was most favorable due to the absence of the moon. By the time this appears there will be only one more chance to see a rich annual stream in 1928, namely the Geminids, which come during the first half of December. Can not some of our very numerous inactive members be induced to bestir themselves and make observations on this important stream? The maximum may be expected about Dec. 12, but there are many Geminids per hour for several previous and following days.

The table will show the salient features of the results. In Texas again at-

Date 1928	Began h m	Ended h m	Total	Factor	Meteors	Observer	Station
Oct. 16	14 42	16 12	90	0.9	14	S. Bunch	Ft. Worth, Texas
17	14 15	16 50	155	0.8	30	S. Bunch	Ft. Worth, Texas
19	14 00	16 01	121	0.8	29	S. Bunch	Ft. Worth, Texas
19	11 45	15 45	240	1.0	21	B. Sanders	Ft. Worth, Texas
20	11 37	17 55	378?	0.4	30	B. Sanders	Ft. Worth, Texas
20	11 37	17 55	?	?	12	R. Brown	Ft. Worth, Texas
20	11 37	17 55	300	0.4	39	S. Bunch	Ft. Worth, Texas
20	12 00	15 10	127	0.5	22	J. H. Logan	Dallas, Texas
20	11 50	15 10	137	0.5	13	O. E. Monnig	Dallas, Texas
23	13 56	16 21	145	0.8	33	S. Bunch	Ft. Worth, Texas
23				0.8	3	Mrs. Bunch	Ft. Worth, Texas
23	14 00	16 16	136	0.8	20	B. Sanders	Ft. Worth, Texas
Oct. 19	12 30	14 00	90	1.0	12	G. Watkins	Caldwell, Idaho
Oct. 20	13 37	17 04	139	0.9	37	C. P. Olivier	Flower Obs., Pa.
Sept. 17	14 40	15 15	35	0.8	7	R. A. McIntosh	Auckland, N. Z.
18	14 45	16 35	110	1.0	22	R. A. McIntosh	Auckland, N. Z.
19	14 55	16 30	95	0.7	18	R. A. McIntosh	Auckland, N. Z.
22	13 45	16 35	170	1.0	27	R. A. McIntosh	Auckland, N. Z.

tempts were made to observe meteors simultaneously from two and three stations. Many duplicate observations were secured. Heights and other valuable data will come from their final reductions. Work on the Texas fireball of August 8 has

been resumed and it is hoped that it can soon be completed. Excellent radiants of the Orionids were obtained which will appear later. Using the mean values of the five Texans reporting, magnitudes were recorded as follows: 0 or brighter, 4; first, 31; second, 45; third, 91; fourth, 68; fifth or fainter, 12; total, 251.

R. A. McIntosh observed a fine minor shower on Sept. 18 and 19 in Orion. Five meteors were plotted each night from this radiant, most of them bright and swift. The respective positions of the radiant were:

Sept. 18.67	R.A. 93°.1	Decl. —0°.9
19.67	94.6	0.0

A similar meteor was seen on Sept. 16 and one on Sept. 23 which apparently came from the same radiant area. The shower in any case was a striking one for its kind. Mr. McIntosh has calculated parabolic elements for it which he says resemble those of Comet 1874 III. The writer has not had time to check these figures but will do so shortly and publish the results.

A cordial invitation is again extended to all persons, interested in the subject of meteors, to write for information relative to joining the American Meteor Society. In any case 1928 closes with a record of some of the most valuable work so far done by our members. If the inactive ones would only get busy and do their part, the results for 1929 would be even more striking.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1928 Nov. 14.

COMET NOTES.

By G. VAN BIESBROECK.

The lull in cometary activity that has characterized late months has continued through November. There are no known comets in reach of ordinary instruments. Even for the larger instruments the two comets 1927 *d* (STEARNS) and 1927 *j* (SCHWASSMANN-WACHMANN), which are still under observation, are none too easy. On November 4, I estimated the total brightness of the former visually as $15^{M}.5$ at the Yerkes Observatory. The nucleus was hardly brighter than a 16^{M} star, but the dissymetrical appearance of the coma extending into a short tail in position angle 80° was plainly visible.

On the same night the writer tried to see the second comet but could not find any trace of it with the 40-inch telescope. It is evidently decidedly fainter than comet Stearns.

It is greatly to be feared that comet 1916 I (TAYLOR) will be missed at the present return. The Heidelberg observers report not to have found it on their plates covering the position indicated by the ephemeris. Undoubtedly other observers, who have not reported their unsuccess so far, have also been disappointed. The search is not yet been given up by the writer.

Williams Bay, Wisconsin, November 19, 1928.

COMMUNICATIONS.

Astronomical Productivity. Few books are more generous in giving specific credit to those responsible for the material included than Newcomb-Engelmanns *Populäre Astronomie*, seventh edition. This is a comparatively recent and comprehensive standard treatise on general astronomy, containing 879 pages. There are 880 names included in the index, an average of one per page. It is interesting to note that 218 of these names are those of German astronomers; the United States contributes 152 names, England 151, France 100 and all other countries, including work in mediaeval and ancient times, the remaining 259 names.

One needs to be very careful in drawing conclusions from these numbers. The value of the work done by the individuals whose names are given differs enormously and many are mentioned in one connection only while a few are mentioned many times. There is an abundance of names of astronomers of the present day compared with the number of those living in earlier times for the reason that the work of the latter class, valuable when done, has been superseded, and in some cases the work is so remote that the originator is lost sight of or the knowledge of the work too widespread to require mention of the origin.

In a German book there is likely to be a prejudice in favor of German astronomers because of a greater familiarity with their work because of the common language and personal contacts. Papers not written in one of the principal European languages are largely buried and for this reason these languages are commonly used in scientific publications rather than the native tongue, if another.

It is to be remembered that the populations of the countries differ greatly. In the case of the United States the period of scientific production is shorter. The productivity in the same place changes from time to time and great changes are now taking place. At any rate it stands out clearly that English, German, and French are the languages which are most important to astronomers.

SAMUEL G. BARTON.

University of Pennsylvania, Philadelphia, Pa.

Zodiacal Light Notes.

From Mr. H. F. Donner of the Lamont-Hussey Observatory of the University of Michigan, Bloemfontein, South Africa, three interesting reports of evening Zodiacal Light observations made respectively on August 6, 10, and 16, have been received. These reports show the cone extending 15° on the horizon and 30° along the ecliptic in Leo and Virgo. For the two earlier observations "the brightness of the light was about that of the Milky Way in the region of Scutum." Concerning his observation on August 16, however, Mr. Donner writes: "This was made shortly after a day or two of rain which cleared up the sky considerably, but the light was very much fainter than before. This seems contrary to reason." Other observers have had a similar experience occasionally and the question arises: How can we account for it?

During October, observations of the morning Zodiacal Light and Gegenschein were made by Professor L. B. Allen, Hood College, Frederick, Maryland, and the writer. On October 20 at 4:30 A.M. Professor Allen found the light strong from the western part of Virgo through Leo, the main part of the cone well north of

the ecliptic. On the same morning she found the northern arch of the Gegenschein extending from λ Ceti around to γ Arietis, thence curving into Pisces, indicating a major diameter, east and west, of about 25 degrees. The writer observed the Zodiacal Light at 4:30 A.M., October 22, when the apex of the cone reached almost to Praesepe; sky clear, light strong. On October 7, 9:30 P.M., he observed the Gegenschein easily, but on account of the presence of Jupiter in Aries the limit of the boundary was uncertain. On November 6, 8:30 P.M., he noticed a Zodiacal band extending from the Gegenschein along the ecliptic to the western horizon. The band was well defined; width about 2 degrees.

During December the Gegenschein will be crossing the Milky Way and will not be favorable for observation. While not so well placed as in October and November, the morning Zodiacal Light will still repay the effort made to observe it.

W. E. GLANVILLE.

The Rectory, New Market, Maryland.

GENERAL NOTES.

Prof. F. P. Leavenworth, for many years head of the department of astronomy at the University of Minnesota, died on November 12 at the age of 70 years. We hope to publish a more extensive note on his life and work in a later number.

Mr. S. Plakidis of the National Observatory, Athens, is spending a year in astronomical study in England. He has spent some months at the Greenwich Observatory and is now assisting in the office of the Nautical Almanac, which is under the direction of Dr. L. J. Comrie.

Prof. H. H. Turner, director of the University Observatory at Oxford, has been chosen to represent the British Association for the Advancement of Science at the meetings of the American Association for the Advancement of Science to be held in New York City late in December.

American Astronomical Society.—The forty-first meeting of the society will be held in New York City December 26-29 with Section D of the American Association for the Advancement of Science. The headquarters will be at Hotel Lincoln, Eighth Avenue and 44th Street. The sessions for papers will be held in the physics laboratories of Columbia University.

The Royal Astronomical Society, at its meeting on November 9, listened to papers by Professors Chapman, Greaves, Milne, Smart, and Dyson. After the meeting, as is customary, the Royal Astronomical Society Club met for dinner at the "Criterion" in Piccadilly Circus. Here mention was made of the granting of medals to two of the members, a Royal Medal to Professor Eddington for his remarkable researches in Astrophysics and a Copley Medal to Sir Charles Parsons for his contributions to the science of optics. The formal award of the medals was made at the annual meeting of the Royal Society on November 30.

The Editor had the privilege of attending both the meeting of the B.A.A. and of the R.A.S. and greatly enjoyed the hospitality of these societies.

The British Astronomical Association held the first meeting of the present season at the customary place in Sion College on October 31, 1928. The principal feature of the meeting was the address by the retiring president, Dr. W. H. Steavenson. The subject of the address was "The Eye as an Instrument for Astronomical Research." Dr. Steavenson, a physician, was well qualified to discuss the subject and brought before the Association many interesting and useful suggestions. At this meeting the new president, Captain Ainslie, and the other officers for the next two years were installed.

Solar Photography. —As frontispiece we present a reproduction of a photograph of the sun taken by the Rev. Wm. M. Kearons of Bridgewater, Massachusetts, on September 25, 1928. The equipment was of the simplest kind, a 4-inch refractor, an Optimo shutter giving an exposure of 0.01 second and a device for holding a 6½x8½-inch plate at the proper distance from the eye-piece. The sharp focus and fine detail shown in the spot groups are especially good. The original photograph was about 1.5 times the scale of the cut.

The Lamont Expedition of the University of Michigan completed the erection of its observatory in Bloemfontein, South Africa, and the installation of its 27-inch Lamont refractor in the spring of this year. This southern branch of the University of Michigan Observatory has been named officially "The Lamont-Hussey Observatory." Regular observations for the discovery and remeasurement of double stars in the southern skies have been in progress since May 9. The total of discoveries up to October 2 was 410 with as many more remeasured known doubles. A division of the sky has been effected with the Union Observatory. Among the regions assumed by the Michigan observers is Professor W. J. Hussey's unfinished zone from 18° to 22° south declination. The Expedition is being directed by Professor R. H. Curtiss, Director of the University of Michigan Observatory. The staff in Africa includes Doctor R. A. Rossiter, chief observer in immediate charge, M. K. Jessup and H. F. Donner.

New Comet. —As we go to press word comes of the discovery of a new comet by Forbes at Capetown. The following observations have been received:

Date 1928	α h m s	δ ° ′ ″	Mag.	Observer
Nov. 21.0833	12 08 30	—21 42	6	Forbes
24.5717	12 17 59.7	—24 13 32	7	Berman
25.4753	12 20 26.1	—24 49 46	9 phot.	Van Biesbroeck
26.4798	12 23 9.4	—25 29 0	11	Van Biesbroeck

Errata. —

Page 355, line 9 from bottom, *for* 1905 *read* 1925.
Page 470, line 10 from top, *for* $0^d.339$ *read* $0^d.248$.
Page 565, title near middle, *for* Zodical *read* Zodiacal.
Page 565, line 4 from bottom, *for* Antartic *read* Antarctic.

BOOK REVIEWS.

Astronomy and Cosmogony by J. H. Jeans (Cambridge University Press, 1928, 420 pp.)

The volume is divided into the following chapters: The astronomical survey of the universe, The light from the stars, Gaseous stars, The source of stellar energy, Liquid stars, The evolution of the stars, Non-spherical masses—Dynamical principles, The configurations of rotating liquid masses, The configurations of rotating compressible masses, Rotation and fission of stars, The evolution of binary systems, The ages of the stars, The great nebulae, The galactic system of stars, Variable stars, The solar system, Conclusion. In this work Dr. Jeans describes "The present position of cosmogony and of various closely associated problems of astronomy, as, for instance, the physical state of astronomical matter, the structure of the stars, the origin of their radiation, their ages and the course of their evolution." The method of presentation of the argument is mathematical but this need not deter those of limited mathematical attainments from reading the book for it is possible to get the gist of it without following the analysis. Numerous tables and diagrams bring out the essential portions of the material and 16 full-page plates illustrate many of the celestial bodies considered in the text.

To give an adequate idea of the book would require many pages. We hope that this brief note will induce many to read it. Dr. Jeans has done astronomy a real service in writing this book and presenting his interpretation of our present knowledge and conjectures concerning cosmogony. E.A.F.

Our Wonderful Universe by Clarence Augustus Chant. (George G. Harrap & Company, Ltd., London, 1928, 191 pp.)

The purpose of this little book is to create, in the minds of the young people of today, an interest in the heavens. It is written in a clear and interesting manner, and is well illustrated, both by photographs and drawings,—the drawings of the celestial spheres being exceptional, in that they are instinctively recognized as representations of a sphere,—though it is a matter for regret that the actual work of reproduction is of a somewhat inferior quality. In this book the reader is taken out-of-doors to observe the sky, and is then led by simple and logical steps to find the explanation of what he has seen.

This book can be recommended to those who are desirous of learning something of the heavens and to whom the formal "text book" is unattractive, and to anyone who may contemplate the teaching of astronomy as part of a high school course in general science. H.F.B.

Omar Khayyam, Savant et Philosophe, par Pierre Salet, Paris, Librairie Orientale et Americaine, 1927.

M. Salet is an orientalist and an astronomer, a savant and philosopher himself, like that Omar Khayyam whom we remember only as a poet. In his own day, M. Salet reminds us, Omar Khayyam was a distinguished astronomer, philosopher and mathematician, whose labors in algebra and, above all, in astronomy still entitle him to respect. It is no mean achievement to have devised, circa 1080, a calendar more accurate than the Gregorian.

The bulk of M. Salet's book is devoted to a study of Omar Khayyam's phil-

osophy as shadowed forth in the Quatrains. Dante allowed a literal, a mystical and an anagogical interpretation of his Divine Comedy, and Omar would have been as liberal. His commentators have generally shut their eyes to all but one aspect of his verses or forced upon them a construction that should reconcile them with a theory. M. Salet has wisely refrained from attempting to harmonize everything in Omar. Many of the quatrains attributed to him were conveniently fathered upon him by later poets who were fain to use a dead man's name and prestige for their unorthodox musings. But in a life of four score years the Astronomer-Poet, whose intellect embraced every domain of knowledge, could not in his verse, have sounded one unchanging strain; he was not all mystic, as M. Nicolas would have him, neither was he solely the disillusioned, sceptical and charming epicure that most English readers picture him to have been. In a poetic nature, rich, pliant and sensitive like his, through which all doctrines had filtered, there must have been many a play of mood, a great range of spiritual experience, from doubt to ecstatic faith, from materialism to mystic fervor, many and varied chords sounding true each in its turn, but jangling if we imagine them as sounding all together. M. Salet has erred perhaps in applying the term *philosophy* to these revolving moods. Poets are not bound by systems; Omar's philosophy in his *Rubaiyat* is to escape from all bonds of dogma and doctrine into the freedom of poetry. —H. L.

Amateur Telescope Making. — Second edition, (Scientific American Publishing Co., New York. Price $3.00).

This volume of nearly 300 pages is far better than the first edition as it covers many more points in the making of telescopes and gives more information on many others. Among the added features is a group of four chapters on the achromatic objective, several chapters on eye-pieces and how to make them, a chapter on grinding and polishing machines, two chapters on solar research and the spectrohelioscope and many pages of miscellaneous information. This new edition will be of great value to those who have the first edition and will no doubt be the means of inducing many others to try their hand at making a telescope to explore the heavens. It is the only book of its kind known to the reviewer and can be highly recommended as it deals with the subject in a practical way by authors who have actually made the instruments about which they write.

—E. A. F.